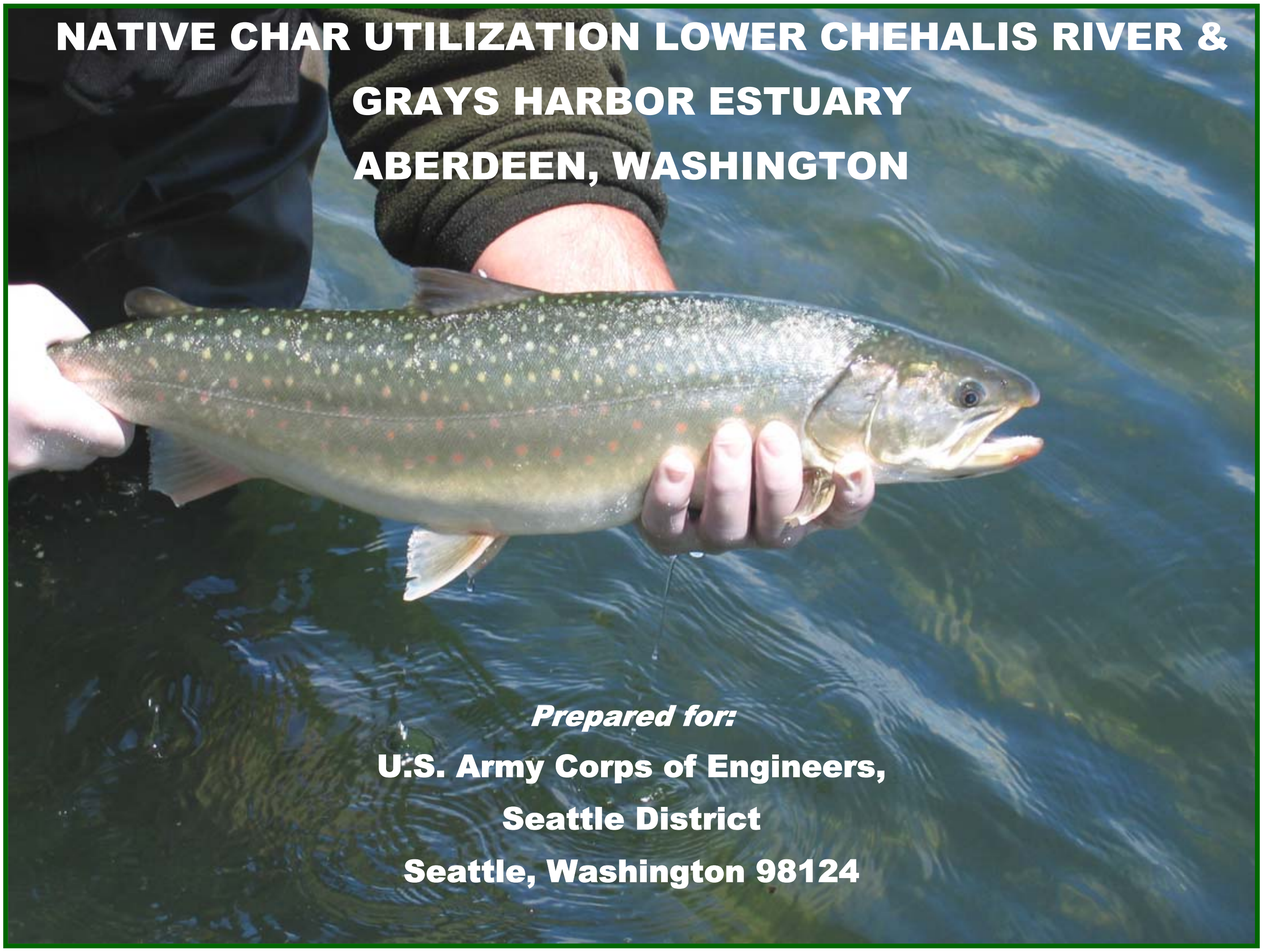
NATIVE CHAR UTILIZATION LOWER CHEHALIS RIVER & GRAYS HARBOR ESTUARY ABERDEEN, WASHINGTON



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Grays Harbor Estuary
Aberdeen, Washington

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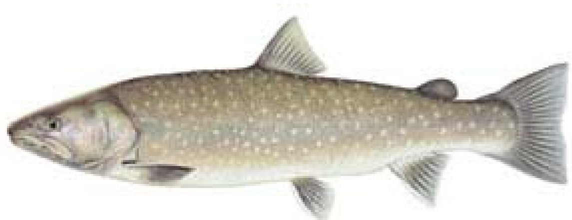

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1. INTRODUCTION

The Grays Harbor Federal Navigation Channel (Navigation Channel) begins in the Pacific Ocean and continues through Grays Harbor to the Chehalis River near the city of Cosmopolis in Grays Harbor County, Washington. The navigation channel is approximately 22 miles long (covering ~ 1,300 acres) and is divided into 11 reaches. The US Army Corps of Engineers (Corps) dredge annually to maintain the Navigation Channel's dimensions. Channel maintenance involves dredging selected areas that have developed shoals as well as maintaining turning basins. The upstream reaches of the navigation channel are within the river's thalweg near the mouth of the Chehalis River. These reaches, especially the turning basins, often require more extensive dredging to meet the target channel dimension because they accumulate bedload transported downstream from the Chehalis River.

The U.S. Fish and Wildlife Service (USFWS) has expressed concern that channel maintenance in the Chehalis River may impact coastal/Puget Sound bull trout (*Salvelinus confluentus*), a native species of char that is listed as threatened under the Endangered Species Act (64 *Federal Register* 58910). Specifically the USFWS believes that channel maintenance activities may exclude native char from habitats in the lower Chehalis River due in large part to the reduced water quality associated with the dredge plume, and from the loss of benthic prey resources while disturbing river or estuarine sediments. Currently, the USFWS has restricted the Corps to allow in-water work to occur from July 16 through 31 August, and 15 October through 15 February, a period "when bull trout are least likely to be in those designated areas of the estuary" (USFWS 2003). The timing window was based on migration information for native char provided by Kraemer (1994) and refined Goetz et al. (2004), which indicated that native char in northern Puget Sound, Washington migrate to the estuary from January through May and then re-enter the river from June through July. Most adult fish enter the estuary in February and March and leave the estuary between May and June to return upstream.

In response to previous USFWS "bull trout work windows" for the Navigation Channel, the Corps initiated several conservation measures to minimize the detrimental effects of channel maintenance activities to native char residing in the Chehalis River basin. In addition, the USFWS required the Corps to design and conduct a three-year native char monitoring plan as a Reasonable and Prudent Measure under the Biological Opinion for Grays Harbor and Chehalis River Navigation Dredging (USFWS Reference 1-2-00-F-0577). The monitoring plan, designed in consultation with the USFWS (J. Chan, Fish Biologist, USFWS), would establish patterns of native char use within lower Chehalis River/Grays Harbor estuary to substantiate bull trout work windows. In January 2001, the Corps contracted with R2 Resource Consultants, Inc. (R2), to conduct biological monitoring within the upper segments of the Grays Harbor Federal Navigation Channel. The overall objective of this study was to determine whether native char are present in the lower Chehalis River/Grays Harbor estuary (Cosmopolis to the mouth of the Hoquiam River) during the periods spanning from 14 February through 30 September. Specifically, the scope of work identified four tasks:

- Determine the presence/periodicity of native char in the lower Chehalis River/Grays Harbor estuary;
- Determine the age and growth of native char inhabiting the lower Chehalis River/Grays Harbor estuary;
- Determine the genetic composition of native char inhabiting the lower Chehalis River/Grays Harbor estuary; and
- Collect age/growth, genetic, and stomach samples from cutthroat trout inhabiting the lower Chehalis River/Grays Harbor estuary.

To assess the presence/periodicity of native char in the lower Chehalis River/Grays Harbor estuary, R2 conducted two separate but interrelated tasks. First, a thorough literature search was conducted to determine the historical observations of native char in the lower Chehalis River. Secondly, a study plan was designed to assess the current presence/periodicity of native char in the lower Chehalis River/Grays Harbor estuary using beach seine surveys as the primary capture technique. The beach seine surveys focused on the periods of time when historical observations indicated that native char were either migrating into the lower Chehalis River or outmigrating to the Pacific Ocean. Following capture, native char were surgically implanted with acoustic transmitters to allow for multiple observations without the repeated handling stresses associated with manual recapture (i.e., beach seine). The following report describes the methods and results of R2's analysis of native char utilization of the lower Chehalis River/Grays Harbor estuary.

2. ENVIRONMENTAL SETTING

2.1 STUDY AREA

Grays Harbor is located on the Washington coast at the mouth of the Chehalis River, approximately 45 miles north of the mouth of the Columbia River and 110 miles south of the entrance to the Strait of Juan de Fuca. Grays Harbor receives discharge from a 2,550 mi^2 watershed containing the Chehalis, Humptulips, Hoquiam, Wishkah, Johns, and Elk rivers (Figure 1), making it the fourth largest estuarine environment in the western United States (Seiler 1989; USACE 1998). The Chehalis River drains approximately 2,200 mi^2 and contributes greater than of 80% of the freshwater flow into Grays Harbor estuary making it the largest watershed in Washington outside of the Columbia River system (Seiler 1989; USACE 1998).

Extreme semi-diurnal tides fluctuate over nine feet in the spring causing expansive mudflats to be exposed in Grays Harbor and an extensive labyrinth of channels forming at ebb tide (Figure 1). The surface area of Grays Harbor ranges from approximately 38 mi^2 at mean low water to 94 mi^2 at mean high water (USACE 1998). Grays Harbor is composed of both estuarine and open-water (ocean) habitats (Levinton 1982). The lower Chehalis River and inner harbor are heavily populated and industrialized (Seiler 1989). The outer harbor (i.e., North and South bays) is sparsely populated, considerably wider, and primarily comprised of shallow estuarine habitats enclosed by two spits, Point Brown to the north and Point Chehalis to the south (Seiler 1989; USACE 1998).

The study area within the Navigation Channel is located within the extent of tidal influence on the floodplain of the brackish-tidal freshwater transition zone of the lower Chehalis River. The tidal influence generally extends upstream approximately 13.5 miles in the Chehalis River (Moser et al. 1991). The study area began at the mouth of the Hoquiam River and extended upstream approximately 5.5 miles to the city of Cosmopolis, Washington. The study area is located within the upstream segments of the Navigation Channel. The study area can generally be divided into three segments: the upstream segment (upstream from Cosmopolis) is primarily rural in nature with undeveloped shrub/scrub forested shorelines; the middle segment (Cosmopolis downstream to Highway 101) is predominantly channelized and confined between riprap levees with increased industrialization and commercial development; while the downstream segment (Highway 101 downstream to the mouth of the

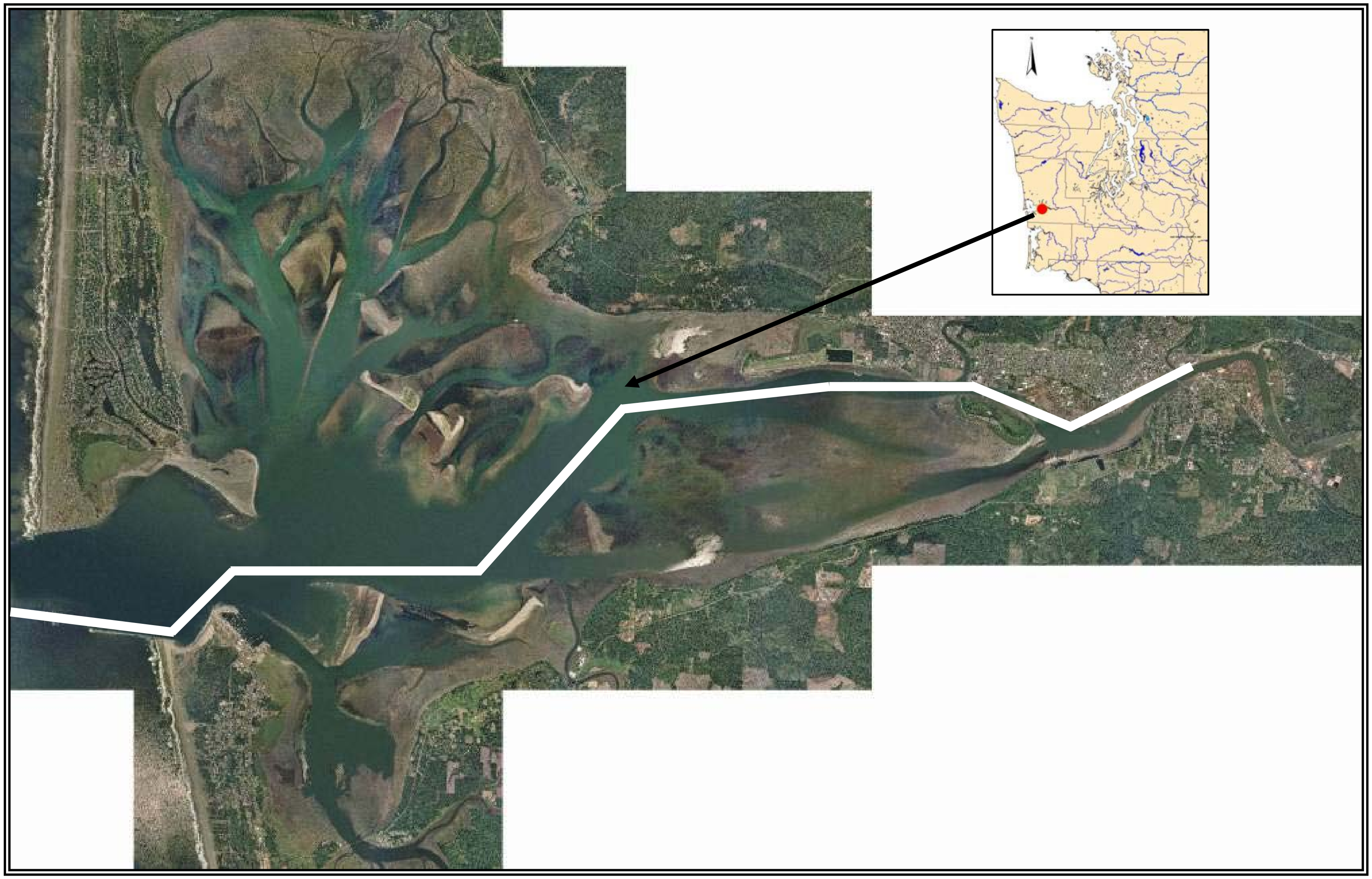

Figure 1. Grays Harbor Federal Navigation Channel, Westport, Washington.

Hoquiam River) is comprised of a broader channel and exposed to increased wave action from Grays Harbor estuary

2.2 AQUATIC RESOURCES

Both anadromous and euryhaline fish species inhabit Grays Harbor (Simenstad et al. 2001; Jeanes et al 2005). Deschamps et al. (1971) found more than 20 fish species during beach seining activities conducted in upper Grays Harbor. Over fifty resident and anadromous fish species have been documented to occur in Grays Harbor, including six species of salmonids (USACE 1998; Jeanes et al. 2005). Chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), and coho (*O. kisutch*) salmon, steelhead (*O. mykiss*), coastal cutthroat trout (*O. clarki clarki*), and native char (*Salvelinus spp.*) reside in the waters of Grays Harbor during portions of their histories. Various other perch, sculpin, flatfish, rockfish, and herring-like fishes inhabit Grays Harbor, most notably shiner perch (*Cymatogaster aggregata*), Pacific staghorn sculpin (*Leptocottus armatus*), starry flounder (*Platichthys stellatus*), black rockfish (*Sebastes melanops*), and surf smelt (*Hypomesus pretiosus*). The following sections describe key life history characteristics and residency periods for the salmonid species present within the project area. The native char section includes the presence/periodicity information that was collected during the literature search that was conducted to determine the historical observations of native char in the lower Chehalis River/Grays Harbor.

2.2.1 Native Char

Bull trout and Dolly Varden (*S. malma*) are two native char species present in western Washington. Bull trout and Dolly Varden are difficult to distinguish based on physical characteristics, and both have similar life history traits and habitat requirements (WDFW 1998). Because the species are closely related and have similar biological characteristics, the Washington Department of Fish and Wildlife (WDFW) manages bull tout and Dolly Varden together as “native char” (WDFW 1998). Section 4(e) of the ESA provides for the listing of a non-threatened species if the listing of this species provides a greater level of protection to the listed species. The USFWS indicated in January 2001 that Dolly Varden are being considered for listing as threatened due to their similarity of appearance to bull trout (66 *Federal Register* 1628).

Bull trout can exhibit numerous life history strategies including an anadromous form, and three diadromous forms; adfluvial, fluvial, and resident (Pratt 1992). Historically, in Washington bull trout were primarily thought of as an inland, freshwater species (WDFW

1998). Recent studies indicate that anadromous populations are present in Puget Sound and coastal drainages (Goetz et al. 2004; Brenkman and Corbett 2005). Anadromous bull trout are now thought to only exist where their coastal ranges overlap with Dolly Varden (Haas and McPhail 1991; Haas and McPhail 2001). Studies in the Skagit and Snohomish River systems provide information on the migration patterns of native char, but in most cases no differentiation was made between bull trout and Dolly Varden so they are grouped together as native char (WDFW 1999). In Puget Sound, native char sub-adults migrate downstream between April and May at two or three years of age. Sub-adult native char in the Skagit River are approximately 150-160 mm total length when they are captured in the screw trap (~ RM 17.0) near Burlington, Washington (D. Seiler, WDFW, *unpublished data*). Yates (2001) capture of eleven native char in the Swinomish Channel (weighted mean length = 157.3 mm) implies that sub-adult char may move quickly through the lower reaches of their natal river and enter marine environment to rear during the spring and most of the summer. The distribution of char in the marine waters is hypothesized as correlated to the nearshore distribution of baitfish (WDFW 1999); however no formal dietary analysis of anadromous bull trout has been conducted. During their marine residence, sub-adult native char experience rapid growth, perhaps as much as 25-40 mm per month (Kraemer 2003). By early autumn sub-adult native char are approximately 250-300 mm long when they move back to the lower portions of their natal streams where they are thought to overwinter. Native char migrate back to the marine environment as early as February where they spend several months in preparation for the spawning migration. Mature native char (age=4, >400 mm in length) leave the tidal waters in May through July and begin their upstream spawning migration.

Historically, little effort has made to separate bull trout from Dolly Varden during surveys conducted in Washington State, the assumption being that the two species have very similar life histories. This suggests that the known life history patterns of Dolly Varden will be applicable to sympatric populations of anadromous bull trout. Bernard et al. (1995) studied the anadromous migration of the southern form of Dolly Varden, whose range extends from the Aleutian Islands to the Washington coast. Although life history patterns among Dolly Varden populations are variable, most reside up to four years in their natal streams. They migrate downstream in the spring, and reside in nearshore, sub-tidal waters. Mature Dolly Varden return to their natal streams in the autumn to spawn and were believed to spend the winter in freshwater. However, 14-58% of the anadromous Dolly Varden in the study population did not return to freshwater in the autumn and were thought to overwinter at sea (Bernard et al. 1995).

Sympatric populations of bull trout and Dolly Varden on the Washington coast and in the Puget Sound were documented by Leary and Allendorf (1997) and McPhail and Taylor (1995), respectively. Samples taken from the East Fork of the Quinault River revealed bull trout and Dolly Varden, but only Dolly Varden were found in smaller tributaries. No evidence of hybridization was found in the bull trout or Dolly Varden, but other recent studies have found hybridization between the two species in British Columbia (Taylor et al. 2001). Genetic analysis conducted by Hagen and Taylor (2001) and Taylor et al. (2001) indicated that hybridization between bull trout and Dolly Varden occur in the Thutade Lake watershed in north-central British Columbia; however, despite this genetic introgression, the authors concluded that the bull trout and Dolly Varden populations have distinct gene pools. McPhail and Taylor (1995) found hybridization as well as backcrossing between upper Skagit River bull trout and Dolly Varden. More recent genetic analyses indicate that, within Puget Sound, all native char residing within the anadromous zones are bull trout, while Dolly Varden are only found upstream from anadromous barriers (M. Downen, WDFW, *pers. comm*.).

Historical Occurrence of Native Char within the Project Area

Ten native char subpopulations exist in five river basins on the western Washington coast including; Quinault (5), Hoh (2), Queets (1), Quillayute (1), and Chehalis (1) rivers (64 *Federal Register* 58913). Together, subpopulations of native char on the Washington coast appear to be in low abundance and are thought to be at the southern end of the range for coastal bull trout and Dolly Varden (64 *Federal Register* 58913). According to the WDFW (1998), native char stocks in the Quinault and Queets rivers are healthy. Olympic National Park biologists have snorkeled the rivers and have observed native char in the anadromous sections of both rivers. Brenkman and Corbett (2005) found that over half (39 of 73) native char tagged in the Hoh River moved into the Pacific Ocean during their radio telemetry study conducted on the Olympic Peninsula during 2002-2003. The Hoh River is thought to have the largest population of native char on the Washington coast, but the population declined substantially from 1982 to 1992. Olympic National Park biologists documented native char during snorkel surveys, and anglers in the anadromous section of the river commonly catch char. Native char have been observed above the anadromous barrier in the Quillayute River, but there are no documented reports of native char within the anadromous zone.

Previous to this study, little information was available concerning the population status of native char in the Chehalis River/Grays Harbor system. Most of the data is from anecdotal accounts from sport fishermen reporting that the majority of native char are "457 millimeters or larger fish" (WDFW 1998) or from juvenile salmonid survival studies that captured native char in beach seine surveys incidentally. These studies typically examined the outmigration patterns of juvenile salmonids, focusing on coho salmon, chum salmon, and Chinook salmon, and were conducted from 1966 through 2000. Native char were not targeted during these studies and so in many cases, length, weight, and age/growth information is not available. An exhaustive search of the juvenile salmonid literature from lower Chehalis River/Grays Harbor documented 15 native char captures (see Appendix A for original report excerpts) beginning in 1966 and most recently in 2000 (Table 1; Figure 2). Juvenile salmonid surveys were also conducted in Grays Harbor estuary, as well as river tributaries to the system.

A large native char (5 lb male) was captured by Deschamps and Wright (1970) in a beach seine in 1966 near Cow Point in April. Tokar et al. (1970) caught three native char in May 1968 near Cow Point. Brix (1974) collected one native char near Moon Island on 4 March 1973, and one native char on 19 March 1973 near Oakville on the Chehalis River (approximate RM 47). Brix et al. (1974) captured three native char near Moon Island in 1974. One char was captured on 20 May and two were captured in July (1 July and 14 July). Brix (1981) collected three native char near Moon Island in 1977 (18 March, 2 May, and 15 June). Simenstad and Eggers (1981) reported catching two native char at Cow Point in March 1981, measuring 550 mm and 440 mm. The most recent char capture occurred in April 2000 by Simenstad et al. (2001) while monitoring a slough restoration site near Cosmopolis. Unfortunately, raw data records for that specific char could not be located (C. Simenstad, University of Washington, *pers. comm.*; A. Wick, Anchor Environmental, *pers. comm.*).

Two native char have been reported in the Chehalis River, upstream from Cosmopolis. As mentioned previously, Brix (1974) collected one native char in a beach seine on 19 March 1973 near RM 47 (Oakville) on the Chehalis River. The other reported native char was a juvenile observed in a downstream migrant trap near RM 50 by the WDFW in 1997 (WDFW 1998). The data record for this char does not exist, however, and the identification of this fish as a native char is questionable (D. Seiler, WDFW, *pers. comm.*). Thus, this observation while noted, is not included in the fifteen historical observations. Brix and Seiler (1977; 1978) operated an inclined-plane screen trap at RM 50 on the Chehalis River in 1976 and 1977. The trap was operated between April 15 and 25 May in 1976, and between 14 April and 22 May in 1977. Juvenile Chinook, coho, steelhead and cutthroat trout were captured, but no native char were observed. Brix (1981) also conducted beach seine surveys on the Wynoochee, Satsop, and Humptulips from 1973 through 1980, and on the Skookumchuck and Wishkah Rivers in 1979 and 1980; however, they did not catch native char in those rivers.

A total of 1,073 beach-seine hauls and 181 tow-net/purse-seine hauls were performed from 1954 through 1980 in the lower Chehalis River/Grays Harbor (see Table 1 for a total reference list). These surveys resulted in a total of 1,254 total hauls (Table 2). Overall, the surveys primarily occurred from February through October, with only 12 hauls conducted in January, November and December. Some historical survey sites were outside of the project area (i.e., Hoquiam River upstream to Cosmopolis). In 1968, sixty-three of the beach-seine hauls and 3 tow-net hauls conducted by Tokar (1970) were either below Moon Island or above Cosmopolis. In 1969, thirty-six beach-seine hauls and 4 tow-net hauls were also conducted below Moon Island or above Cosmopolis. Fyke net surveys have more recently been conducted on two estuarine sloughs in the lower Chehalis River near Cosmopolis (Simenstad 2001). A fyke net was installed at the outlet to two different sloughs (one restoration and one reference slough), and as the tide ebbed, all fish within the sloughs were captured. This work occurred monthly, from March through June in 1990-1992, 1995, and again in 2000 (total effort = 90 slough-sampling-days).

Beach seine, boat electrofishing, and fish traps surveys have been conducted to sample fish residing in tributaries to Grays Harbor. A total of 2,933 beach-seine hauls were conducted from March through October, 1973-1980 (Table 3). A total of 8 man days (hrs not available) were also spent electrofishing the Chehalis River in June through October in 1974 (Brix et al. 1974). A downstream migrant fish trap was operated year-round at a water diversion site on the Wynoochee River (~RM 8) from 1952 through 1955 (Deschamps and Wright 1970). An inclined-plane trap was operated 24-hours a day from 15 April through 15 May 1976 and again from 4 April through 22 May 1977 (Brix and Seiler 1977).

Overall, seine/tow net surveys conducted in the lower Chehalis River/Grays Harbor were generally targeting juvenile salmonids and were primarily focused on the period of time when they were likely to be present (i.e., February through October). Seine/tow net surveys were conducted during the months of November, December, and January at a decreased level of effort (Tables 2 and 3). Overall, within this sampling period, a total of 4,187 seine/tow net hauls captured 15 native char in the lower Chehalis River/Grays Harbor from 4 March through 14 July (0.004 char $haul^{-1}$). The majority of the native char captures (N=12; 80%) occurred during the months of March (N=5; 33%), April (N=2; 14%), and May (N=5; 33%). The March through May time period generally corresponds to months with the highest overall effort (March = 11.23%, April = 18.75%, May = 20.49%, June = 17.94%, and July = 10.27%).

Table 1. Historical native char observations, Chehalis River basin, Aberdeen, Washington.

Char No.	Source	Location	Year	Date	Comments
1	Deschamps and Wright (1970)	Cow Point	1966	27 April	5 lb. male
2	Tokar (1970)	Cow Point	1968	3 May	
3	Tokar (1970)	Cow Point	1968	17 May	
4	Tokar (1970)	Cow Point	1968	28 May	
5	Brix (1974)	Moon Island	1973	4 March	
6	Brix (1974)	Oakville	1973	19 March	~RM 47
7	Brix et al. (1974)	Moon Island	1974	20 May	
8	Brix et al. (1974)	Moon Island	1974	1 July	
9	Brix et al. (1974)	Moon Island	1974	14 July	
10	Brix (1981)	Moon Island	1977	18 March	
11	Brix (1981)	Moon Island	1977	2 May	
12	Brix (1981)	Moon Island	1977	15 June	
13	Simenstad and Eggers (1981)	Cow Point	1981	March	440 mm
14	Simenstad and Eggers (1981)	Cow Point	1981	March	550 mm
15	Simenstad et al. (2001)	Cosmopolis	2000	April	~ RM 6 slough

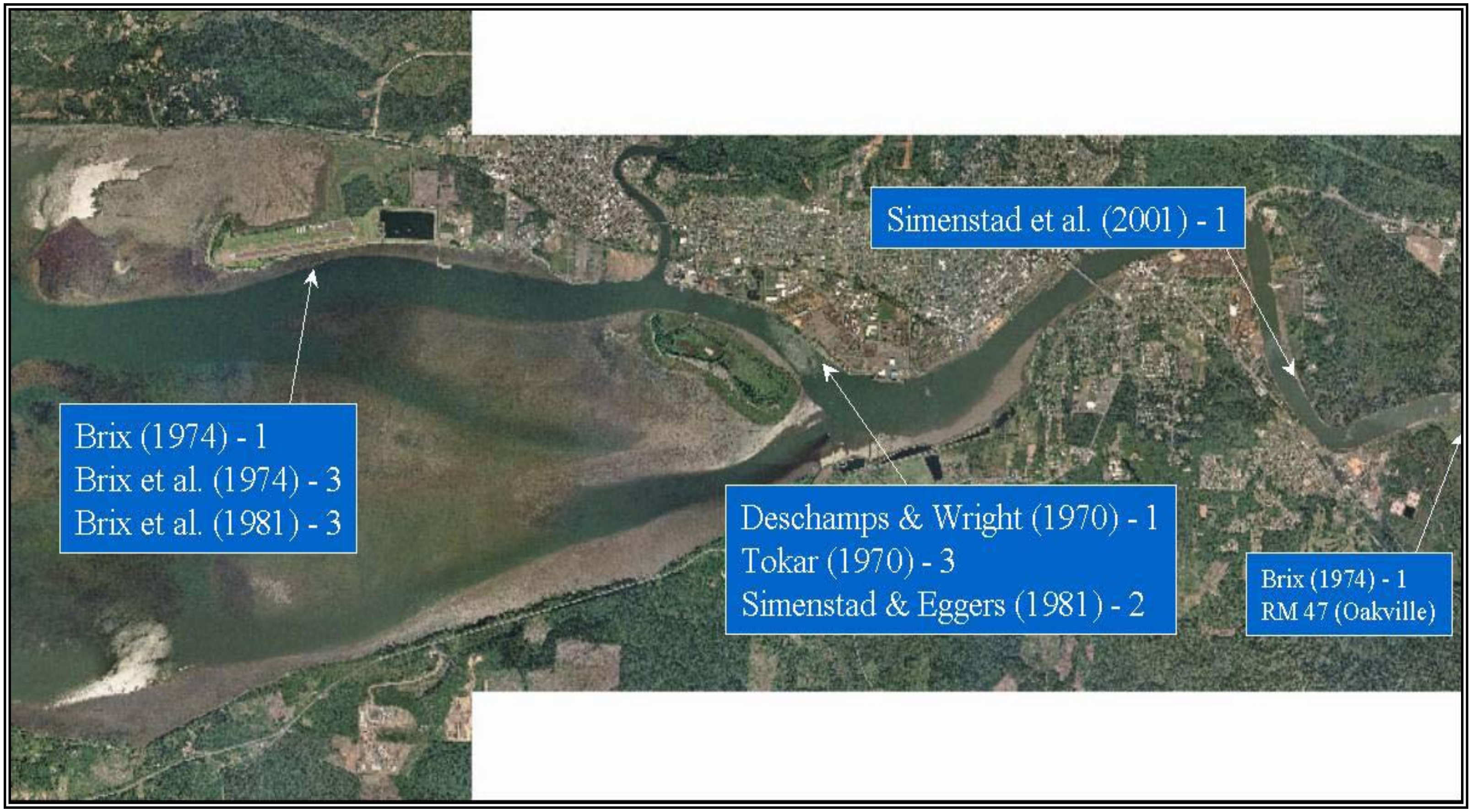

Figure 2. The location of fifteen (15) historical native char observations in the Chehalis River basin, Washington, 1966-2000.

Table 2. Monthly level of effort (seine/tow net hauls) for historical native char observations within the lower Chehalis River/Grays Harbor, Aberdeen, Washington (BS=beach seine; TN=tow net; PS=purse seine).

Source	Gear Type	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Deschamps and Wright (1970)	50 ft BS	1954			4	8	12	8	8	8					48
	50 ft BS	1955						2	6	4					12
	50 ft BS	1956						2	2	6	2				12
	50 ft BS	1957	2	6	8	6	10	8	8	4					52
	50 ft BS	1961		4	4	2	4		2	2					18
	100 ft BS	1965	2	4	6	6	6	8	6	2	1				41
	50 ft BS	1965	2	3	6	6	6	8	6	4	4	2			47
	50 ft BS	1966			1	12	15	3		2	7				40
Tokar (1970)	100 ft BS	1968			1	6	22	14	30	16	19	15	1		124
	TN	1968							3	4	2	4			13
	100 ft BS	1969		9	9		9	10	12	6	8	6	3		72
	TN	1969			8		9	5	4			2	1	1	30
Brix (1974)	75 ft BS	1973			17	15	17	23	19	14	15				120
Brix (1981)	75 ft BS	1974			10	11	12	10	12	15	8				78
	75 ft BS	1975			6	20	12	13	11	8					70
	75 ft BS	1976				15	11	12	14	5					57
	75 ft BS	1977			3	8	11	10	4						36
	75 ft BS	1978			6	8	8	7	6	3					38
	75 ft BS	1979			4	11	6	7	6						34
Simenstad and Eggers (1981)	121 ft BS	1980			20	21	20	21	20	21	20	21			164
	207 ft PS	1980			18	19	18	19	18	19	18	19			148
Total Effort			6	26	131	174	208	190	197	143	104	69	5	1	1,254
Percentage of Total Effort			0.48	2.07	10.45	13.88	16.59	15.15	15.71	11.40	8.29	5.50	0.40	0.08	100.00

Table 3. Monthly level of effort (seine/tow net hauls) for historical native char observations within the tributaries to Grays Harbor, Washington (BS=beach seine).

Source	Gear Type	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Brix (1974)	75 ft BS	1973			106	110	126	85	90	85	81	39			722
Brix (1981)	75 ft BS	1974			42	59	80	70	88	83	82	46			550
	75 ft BS	1975			43	96	87	80	80	50	10				446
	75 ft BS	1976			13	66	68	59	33	5					244
	75 ft BS	1977			7	71	43	29							150
	75 ft BS	1978			42	46	44	45							177
	75 ft BS	1979			38	78	100	94							310
	75 ft BS	1980			48	85	102	99							334
Total Effort					339	611	650	561	233	223	175	85	0	0	2,933
Percentage of Total Effort			0.00	0.00	11.56	20.83	22.16	19.13	7.94	7.60	5.97	2.90	0.00	0.00	100.00

2.2.2 Other Salmonid Species

Other salmonid species inhabiting Grays Harbor include Chinook, chum and coho salmon, rainbow/steelhead and coastal cutthroat trout. Resident and/or anadromous salmonids may be present in the lower Chehalis River/Grays Harbor project area throughout the year (Deschamps et al. 1971).

Chinook salmon

Mixed (native and non-native origin) spring and fall Chinook occur in the Grays Harbor system (WDFW et al. 1994). Timing of entry into estuaries varies considerably for juvenile Chinook salmon (Healey 1982; 1991). Most juvenile Chinook that migrate to salt water as subyearlings (fry), termed ocean-type, are primarily progeny of fall Chinook stocks (Healey 1991). A smaller percentage of juvenile Chinook that enter salt water as yearlings (termed stream-type) are the progeny of spring Chinook stocks. Peak yearling migration occurs in late April through early June, while fry migration to salt water occurs earlier, typically from April through late May (Simenstad et al. 1982; Healey 1991). Congleton et al. (1982) reported that Chinook fry (42-60 mm FL) were abundant in the Skagit River estuary from late April through May. Brix (1981) found peak catches of Chinook fry in Grays Harbor during mid-June, but continued to capture subyearling Chinook near the mouth of the Hoquiam River from early March through September. Estuarine residency periods of juvenile Chinook can range from as short as six weeks (northern Puget Sound) to 29 weeks (Grays Harbor) (Simenstad et al. 1982). Owing to their many life history patterns, juvenile Chinook occupy the widest variety of estuarine habitats (Healey 1982; Simenstad et al. 1982; Healey 1991). Chinook fry frequent the same estuarine habitat as chum fry, while yearling Chinook are generally found in neritic habitats, bypassing shallow water estuarine habitats (Healey 1991). After rearing in the estuary, Chinook salmon will typically spend three to four years in the ocean before returning to spawn. Peak river entry timing for Chehalis River spring Chinook is not known, but is believed to be in January and February (WDFW et al. 1994). Fall Chinook will begin to enter Grays Harbor in early September, and peak in October (WDFW et al. 1994).

Chum Salmon

Juvenile chum salmon seaward migration is directly related to latitude, and typically peaks in Washington during late March through early May (Simenstad et al. 1982; Salo 1991). Congleton et al. (1982) found that juvenile chum abundance increased from March through early May, peaking in late April and early May, in the Skagit River estuary. After the first week in May, chum abundance declined until only "a few hundred" remained by the end of June, and no chum fry were captured in early July. Juvenile chum in the Skagit River estuary ranged from 40-48 mm FL. Deschamps et al. (1971) captured juvenile chum salmon (38-40 mm mean FL) in upper Grays Harbor (near mouth of Hoquiam River) from early February through mid-June. Juvenile chum salmon estuarine residence periods have been reported as short as five weeks (Quillayute River estuary), to as long as 23 weeks (Hood Canal) (Simenstad et al. 1982). Chum fry often reside in schools in shallow sublittoral areas (e.g., salt marshes and shallow bays containing eelgrass) until they reach 50-60 mm fork length, when they become more common in deeper neritic habitats (Healey 1982; Simenstad et al. 1982; Salo 1991). Adult chum typically return from the ocean to Grays Harbor in early October, with peak entry in early November (WDFW et al. 1994).

Coho Salmon

Coho salmon migrate to salt water during April and June, after spending one year of residency in fresh water habitats (Sandercock 1991). Durkin (1982) captured coho smolts (110-160 mm FL) in the upper Columbia River estuary for six weeks between late April and early June, peaking from 6-17 May. Migration of larger smolts usually occurs earlier and more rapidly than smaller coho smolts. Catches of juvenile coho salmon (71-106 mm FL) peaked in mid- and late May and again in early July on the lower Snohomish River (Pentec 1992). Brix (1981) reported catching yearling Chinook in upper Grays Harbor from April through June, peaking in early May. Like yearling Chinook salmon, coho generally spend less time in shallow water areas, and enter neritic habitats almost immediately upon entry to the estuary, preferring exposed cobble or gravel beaches (Healey 1982; Simenstad et al. 1982; Sandercock 1991). Adult coho return to Grays Harbor from mid- to late-September through mid-December (WDFW et al. 1994).

Rainbow Trout

Steelhead, the anadromous form of rainbow trout, spend the first one to several years of their life in freshwater before migrating to saltwater. Steelhead typically return to freshwater to spawn within 2 to 4 years (Busby et al. 1996). Unlike the other Pacific salmon species, steelhead do not die after spawning and are capable of spawning in successive years (iteroparous). Steelhead are divided into two groups based on sexual maturity when entering freshwater. Summer (termed stream maturing) steelhead enter freshwater in an immature state, while winter steelhead (termed ocean maturing) enter freshwater with well-developed sexual organs (Busby et al. 1996). Two wild summer and eight wild winter steelhead stocks have been identified in the Grays Harbor watershed (WDFW et al. 1994). Approximately 130,000 to 350,000 hatchery winter steelhead smolts and 40,000 to 50,000 summer steelhead smolts are stocked in the Chehalis River system annually (Busby et al. 1996). Chehalis River steelhead are classified as part of the southwest Washington ESU (1 of 15 west coast steelhead Evolutionarily Significant Unit). The National Marine Fisheries Service (NMFS) concluded that the southwest Washington ESU is presently not in danger of extinction nor likely to become endangered in the foreseeable future (Busby et al. 1996).

Coastal Cutthroat Trout

Coastal cutthroat trout exhibit early life history characteristics similar to coho and steelhead whereby juveniles spend an extended time rearing in freshwater before outmigrating as smolts (Leider 1997). Cutthroat trout are also iteroparous, spawning several times during their lifetime. Within a given drainage basin, resident (non-migratory), fluvial (freshwater migrants), and anadromous (marine migrants) life history patterns are often present. Age at first anadromy can vary, but due to their proximity to rough costal waters, cutthroat trout in the Chehalis River probably emigrate to the estuary between ages 3 and 5 (8-10 inches TL) (Johnston 1982). Most coastal cutthroat return to freshwater the same year they migrate to the ocean. Grays Harbor coastal cutthroat have been placed into the Southwestern Washington/Columbia River ESU by the NMFS (Johnson et al. 1999). Habitat degradation along with poor ocean and estuarine conditions have combined to severely restrict the life history diversity of this species. Anadromous coastal cutthroat are virtually extirpated from at least two Oregon rivers draining into the Columbia River. Based on surveys conducted by Weyerhaeuser Corporation and the Quinault Indian Nation in the West Branch Hoquiam

River, it is believed that coastal cutthroat trout are abundant and widespread in Chehalis River/Grays Harbor (WDFW 2000). The Southwestern Washington/Columbia River coastal cutthroat trout were proposed as threatened under the Endangered Species Act by the NMFS and the USFWS on 5 April 1999 (64 *Fed. Regist.* 16397-16414), but were withdrawn from listing on 5 July 2002 (67 *Fed. Regist.* 44934-44961).

3. METHODS

3.1 FISH CAPTURE

As previously mentioned, R2 conducted two separate but interrelated work items during this study. First, a thorough literature search was conducted to determine the historical observations of native char in the lower Chehalis River. Secondly, a study plan was designed to assess the current presence/periodicity of native char in the lower Chehalis River/Grays Harbor estuary using beach seine surveys as the primary capture technique. The beach seine surveys focused on the periods of time when historical observations indicated that native char were either migrating into the lower Chehalis River or outmigrating to the Pacific Ocean. Beach seine and hook and line surveys were conducted in the lower Chehalis River/Grays Harbor estuary during seven (7) separate capture periods that were based upon specific intervals of suggested native char occurrence within the lower Chehalis River:

- 21 June through 25 July 2001 (weekly);
- 21 February through 15 March 2002 (weekly);
- 18 June through 27 September 2002 (one survey per two weeks);
- 27 March through 23 April 2003 (weekly);
- 6 June through 20 June 2003 (weekly);
- 9 September through 19 September 2003 (weekly); and
- 19 February through 26 March 2004 (weekly).

The project area extended from the city of Cosmopolis downstream to the Cow Point Turning Basin near the mouth of the Hoquiam River (Figure 3). Beach seine surveys were conducted at eleven (11) locations in 2001 and twelve (12) locations in 2002 through 2004 that were selected by the Corps in consultation with the USFWS to provide representative sample coverage of the nearshore habitat within the project reach. The 2002-04 survey locations were the same as in 2001 except for an additional study location to test a new seine design. A total of 33 survey trips occurred during the study period (2001=4 survey trips; 2002=12 survey trips; 2003=11 survey trips; 2004= 6 survey trips). Each trip consisted of one day and one night survey (seine haul) at each location resulting in a total of 784 seine hauls (2001=4 trips X 2 surveys X 11 sites=88 seine hauls; 2002=12 trips X 2 surveys X 12 sites=288 beach seine tows; 2003=11 trips X 2 surveys X 12 sites=264 beach seine tows; 2004=6 trips X 2 surveys X 12 sites=144 beach seine tows). The day/night beach seine surveys generally corresponded with the either the high or low slack tide. Day and night surveys were conducted within the same 24-hr period; however, since night surveys typically finished after midnight, all night survey dates correspond to the day following daytime sites for data clarity (Figure 4).

The survey locations began at the mouth of the Hoquiam River and proceeded upstream to a point approximately 0.25 miles upstream of the Cosmopolis boat launch (Figure 3). The survey sites were identical throughout the six study periods except for the Test Site (Site 11), which was added during the 2002 study period (see Appendix B for site photographs). The Test Site (Site 11) was located immediately (~50 ft) downstream from Site 10 for comparison purposes (Table 4).

A 121 ft-long, 6.5-ft (37- X 2-m) deep beach seine constructed of two 59-ft (18-m) wings, each composed of 0.25-inch (6-mm) mesh, was used during each sample effort (Figure 5). The central bag measured 6.5-ft (2-m) deep by 3-ft (1-m) wide and was constructed of 0.2-inch (5-mm) treated knotless nylon mesh. Each wing was attached to 2-in. (51 mm) diameter, 6.5-ft (2-m) long wooden poles with a stainless steel ring at the center of the leads. The test net was constructed to the exact dimensions as the regular seine, except utilizing 1.5-inch (35-mm) mesh wing material and 0.5-inch (13-mm) mesh in the central bag. The beach seine was deployed by boat using 100-ft (30-m) long lead ropes attached to the stainless steel rings. One end of the seine was pulled in a semi-circular fashion while the other end was secured to the shore using a fluke-style anchor. The seine was manually retrieved parallel to shore using the lead ropes for the first 66 ft (20-m) with wings approximately 130 ft (40-m) apart, and from a distance of approximately 33 ft (10-m) apart for the final 33 ft (10-m) to shore. As utilized in this configuration, the beach seine samples approximately an area of 5,597 ft^2 (520 m^2) and volume of 27,915 ft^3 (790 m^3) (Simenstad et al. 1991).

Hook and line surveys were conducted in concert with beach seine surveys with anglers using single barbless terminal tackle attached to a swivel. After experimentation, it was found that angling occurring during the last portion of the flood tide maximized catch rates. The use of a swivel allowed native char to spin on the line during the capture without causing damage. Anglers used medium-heavy spinning gear to minimize the landing time period of native char.

3.2 FISH HANDLING PROCEDURES

After capture, native char and cutthroat trout were collected immediately from the bag or the dip net (constructed of 3-mm treated knotless nylon mesh) and transferred immediately into a 2- X 2- 4-ft (0.6- X 0.6- X 1.2-m) collapsible live car constructed of 6-mm treated knotless nylon mesh (Figure 6). The live car was secured off-shore using a fluke-style anchor. If the capture site was an extended distance from the live car, native char were transported to the live car via 3- X 0.5-ft (0.9- X 0.15-m) totes constructed of black 3-mm vulcanized rubber. The fish totes were fitted with a shoulder harness and contained approximately 12 L of fresh ambient water.

Surgical gloves were used at all times during all fish handling procedures to prevent infection or de-scaling. All native char were removed from live cars and transferred to 92-quart (87.1 L) marine coolers containing seawater and buffered tricaine methanesulfonate (MS-222) at a concentration of 70 mg • L^{-1}. For the age and growth metric, native char were measured for fork and total length (to nearest mm), and weighed to the nearest 1.0 g. A tissue sample was collected from the anal fin and preserved in 95% ethanol and labeled with an identifying number unique to each sample. Scale samples were collected from native char midway between the dorsal fin and the caudal peduncle, in an area just above the lateral line. The scales were removed using a single scraping motion with a clean knife and placed in waxed paper within scale envelopes and labeled with an identifying number unique to each sample. Cutthroat trout were gastrically lavaged for dietary analysis using a one gallon hand pump; gut contents were preserved in 90% formalin and shipped with a tissue sample and length information to the WDFW for analysis (J. Jaquet, WDFW, *pers. comm.*). On some occasions, adult Chinook and coho salmon were removed from the beach seine with a dip net to preserve the integrity of the set.

3.3 FISH TAGGING

Beginning in 2003, native char were surgically implanted with ultrasonic (acoustic) transmitters (Vemco, Ltd., Shad Bay, Nova Scotia). Acoustic transmitters were selected for this study because, unlike radio transmitters, they are not affected by waters with high conductivity (i.e., saltwater) and extreme water depth (>20 m). Native char were fitted the V8-SC miniature coded transmitters (V8). The V8 transmitter is 28-mm long, 9-mm in diameter, weighs 5 g in air and 3.1 g in water. The projected battery life for this transmitter with various delays between the pulse trains ranges from 112-799 d (Table 5). This pulse train includes unique signals that permit identification of the specific study specimens.

Minimum and maximum delays refer to the time (sec) the transmitter will delay before repeating its coded transmission. All delays are random between this time range and generated by the transmitter. For example, if the acoustic transmitter is programmed to transmit randomly between 30-90 seconds it will have a battery life of approximately 465 days, should the pulse be decreased to 20-60 seconds, the battery projected battery life is 335 d. The majority of the V8 transmitters were programmed at pulse rates of 25-90 seconds to accommodate a battery life of 410-465 d. The pulse rates of transmitters was selected to ensure a high likelihood that multiple study specimens were recorded within the range of one receiver whereby shorter pulse rates could result in transmitter collisions from multiple signals occurring at the same time and result in a missed observation of one or both specimens.

After each fish was transferred from the live to the marine cooler, measured for fork and total length (to nearest mm), and weighed to the nearest 1.0 g, it was prepared for surgery. The surgical procedure was a modification of techniques described by past researchers (Muhlfeld et al. 2003; BioAnalysts 2002; Adams et al. 1998; Fernet and O'Neil 1997; McCleod and Clayton 1997; and Summerfelt et al. 1990). Individual fish were anesthetized in a bath containing 70 mg $\bullet$ L^{-1} MS-222 buffered with sodium bicarbonate to a pH=7 until they lost equilibrium (approximately 90 sec). Native char were removed from the anesthetic and placed on a soft foam pad with a groove cut into it and was soaked in ambient saltwater (Figure 7). Fish were placed ventral side up on the pad and the gills were continuously flushed first with anesthetic (duration= 30-45 sec) and then with fresh ambient water (duration = 30-45 sec). Conducted in this manner, the study specimen was upright and swimming when the surgical procedure was complete.

Other disinfection and sterilization procedures used for the surgical equipment followed procedures described in Summerfelt and Smith (1990). A 10-mm incision was made approximately 3-mm away from and parallel to the mid-ventral line starting approximately 5-mm anterior to the pelvic girdle. Care was taken to barely penetrate the peritoneum; a probe was used to complete the opening so that internal organs were not inadvertently cut. The transmitter was inserted into the body cavity and the position adjusted with a probe so that the transmitter was directly below and horizontal with the incision. The incision was closed with simple, interrupted non-absorbable sutures (Prolene Monofilament Suture No. 8683, 4/0 taper FS2 needle) evenly spaced across the incision (Summerfelt and Smith 1990) (Figure 8). To prevent infection a small amount of Vetbond™ adhesive veterinary glue was placed over the incision. The native char was then placed into a 92-quart (87.1 L) marine cooler containing fresh ambient water and transferred to the live car. Surgical procedures averaged 90 sec, from the point that the native char lost equilibrium to placement into recovery water.

Individually numbered T-bar anchor tags (anchor tags) (Floy® Fish Tags, Seattle, Washington) were inserted just below the dorsal fin at an acute angle so that the tag would lie next to the body when swimming (Figure 9). Care was taken to place the tag behind the pterygiophores to prevent excessive tag loss (Guy et al. 1996). To decrease cumulative stress, the anchor tag insertion and scale/tissue sample collection occurred while the fish was in the recovery water. Seven (7) fish were implanted with acoustic transmitters and the total weight of transmitter never exceeded 2% of the fish's body weight (Winter 1996).

3.4 FISH TRACKING

Fixed monitoring stations employing continuous data loggers (Vemco Ltd. Model VR-2) was the principal technique used to identify migratory behavior and habitat use of native char. The VR-2 is a receiver that can be completely submerged and was primarily used in the nearshore marine habitat. This receiver has an expected battery life of approximately 15 months and employs a hydrophone that is connected directly to the housing of the receiver. All receivers were installed using stainless steel hardware at or below mean tide level using the procedure described in Clements et al (2005) and Welch et al. (2004). Data from fish passing within detection range of the fixed receivers were stored in the memory bank of the receiver until they were downloaded. Data were downloaded into an IBM-compatible notebook computer 4-8 weeks. Nine fixed monitoring locations were installed in the lower Chehalis River/Grays Harbor to bracket the study area (Figure 12).

The migratory behavior and habitat use of native char were also assessed during mobile surveys using the VR-60 receiver, with an attached hydrophone mounted on the end of a 150-cm polyvinyl chloride (PVC) pipe, in a boat. The location was determined using a hand-held GPS instrument, depth was measured using an electronic depth finder, surface, mid-depth, and bottom temperature, salinity, and dissolved oxygen were measured with a YSI or Hydrolab water quality meter. To further define areas of native char habitat use, the horizontal fish position was noted as follows: 1) main or off-channel; 2) within a channel either mid-channel or shoreline; 3) shoreline type as either hydromodified, natural bank, natural bank with wood; 4) substrate type as either mud/organics, sand, gravel, or cobble; and 5) association or proximity to wood as either no wood, within 5-m, and within 25-m. The mobile survey schedule varied over the study period from weekly to monthly or semi-monthly during fixed receiver download/maintenance and fish capture activities.

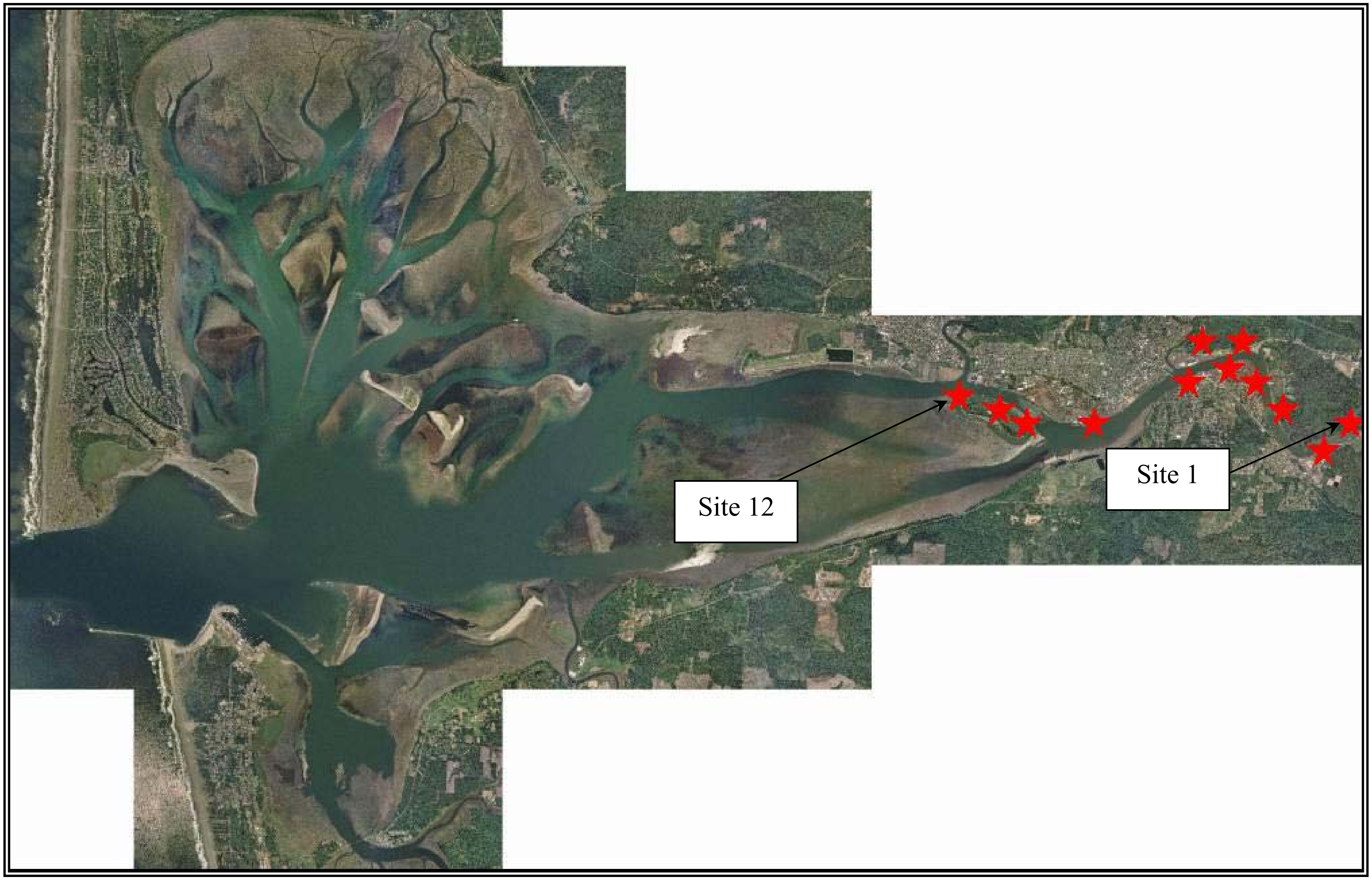

Figure 3. The location of twelve (12) native char beach seine survey sites in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

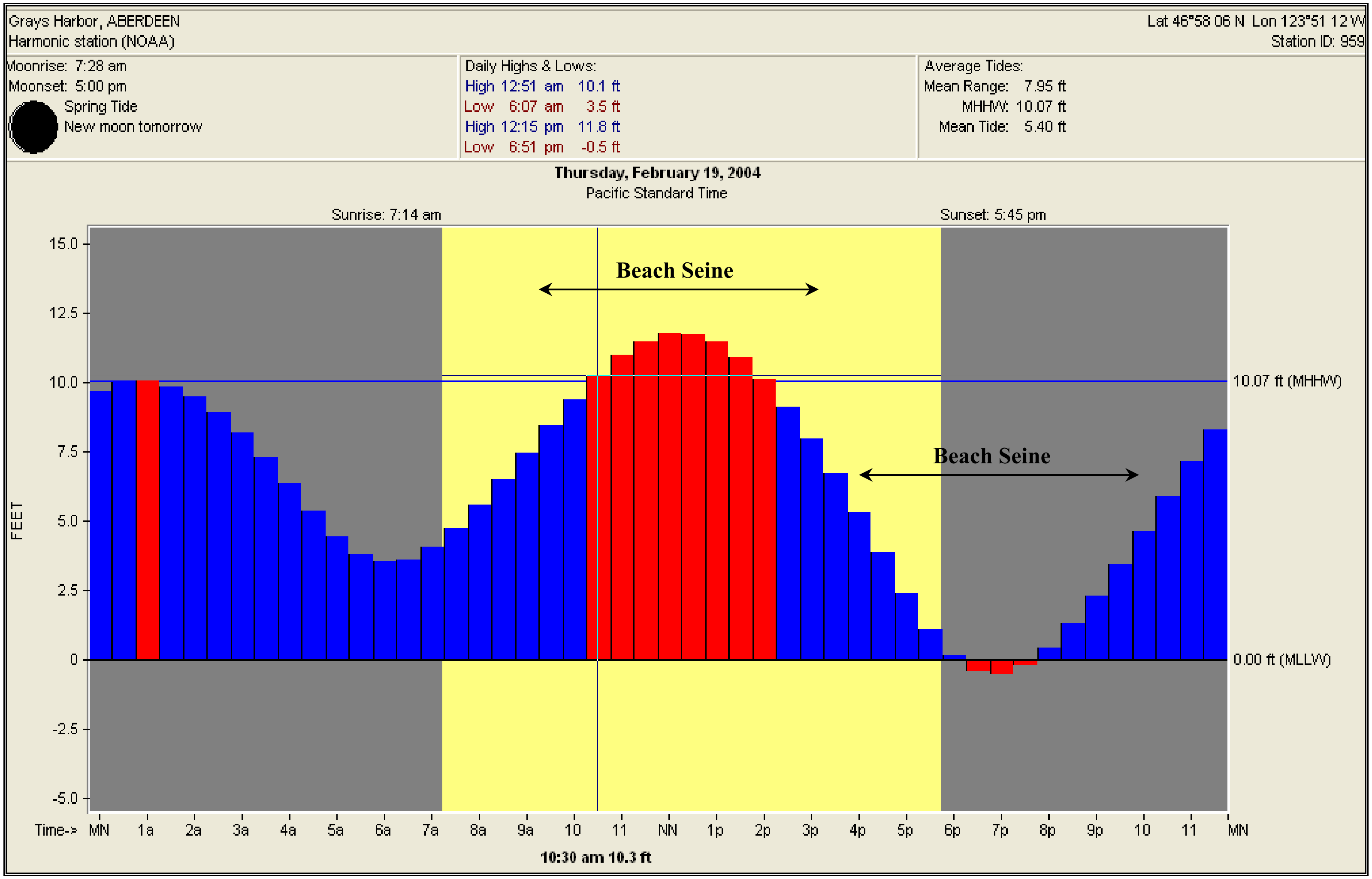

Figure 4. Typical beach seine sampling schedule utilized to capture native char in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Table 4. Name, site number, and physical habitat description of the 12 native char beach seine survey sites, lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Site Name	Site Number	Upper Intertidal Habitat	Lower Intertidal Habitat	River Bank Location
Otterville	1	Low sloping grassy bank with bench	Soft mud substrate, low gradient	Left
Powerline	2	Low sloping grassy bank with bench	Soft mud substrate, low gradient	Left
Big Stump	3	Moderately low sloping forested bank	Low gradient soft mud substrate	Right
Lumberyard	4	Moderately steep bank with riparian vegetation	Sand, cobble substrate	Left
Lakeside Industries	5	Open gravel cobble moderately low slope	Gravel, cobble substrate	Right
Weyerhaeuser	6	Low gradient, shrub cover	Moderately low gradient, sand and gravel substrate	Left
Top Foods	7	Moderately low gradient grassy bank	Soft mud substrate	Right
Boat Launch	8	Low sloping grassy bank	Moderate gradient, hard gravel substrate	Left
Chip Mill	9	Moderately steep bank with some riparian vegetation	Gravel cobble substrate	Right
Bird Island	10	Sandy low gradient slope, protected island	Soft sand substrate, low gradient	Left
Test Site	11	Sandy low gradient slope, protected island	Soft sand substrate, low gradient	Left
Hoquiam River	12	Sandy low gradient slope, protected island	Soft mud and sand substrate	Left

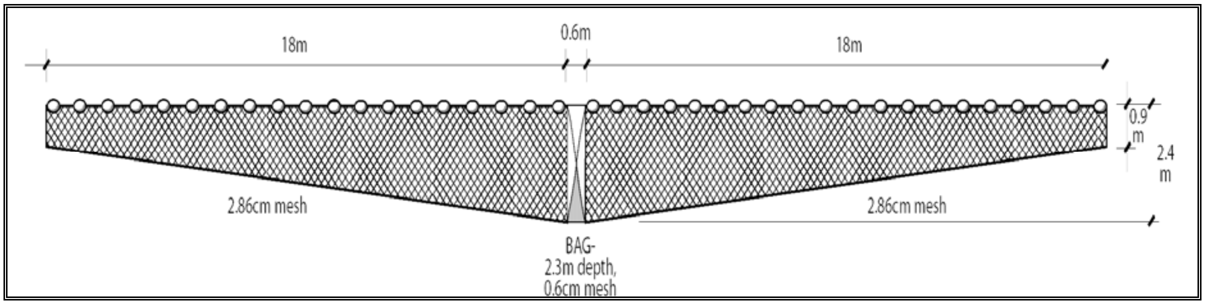

Figure 5. Beach seine used to capture native char lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Figure 6. Live car used during the surgical implant of acoustic transmitters in native char in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Figure 7. Work platform used to surgically implant acoustic transmitters in native char in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Figure 8. Sutures from native char surgically implanted with acoustic transmitters in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Figure 9. Anchor tags from recaptured native char surgically implanted with acoustic transmitters in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Table 5. The approximate battery life of V8 transmitters (with varying pulse delays) used to record the migratory behavior and habitat use of native char in lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Minimum Pulse Delay (sec)	Maximum Pulse Delay (sec)	Approximate Transmitter Battery Life (d)
5	15	112
10	30	190
20	60	335
30	90	465
40	120	585
50	150	697
60	180	799

3.5 AGE/GROWTH ANALYSIS

Ages of native char were estimated by counting the number of annuli on a scale (Devries and Frie 1996). After preliminary experimentation, it was determined that the relatively low (~10-20X) magnification of a microfiche reader did not provide the detail necessary to analyze native char scales. A binocular microscope (100X magnification) was used to provide the magnification needed to identify the annuli and subsequently the age of the fish. A Canon PowerShot™ A40 2.1-megapixel digital camera was used to take digital images of scales through the eyepiece of the microscope. Digital images were manipulated in Adobe Photoshop to maximize the clarity of the annuli on the scales. Images of the scales were printed to aid in the aging procedure.

The native char aging procedure generally followed the guidelines published by Ericksen (1999), Williamson and Macdonald (1997), and Minard and Dye (1998). To minimize within-reader error, each scale was analyzed three times. The previously determined ages were kept unknown to minimize bias by the reader. The mode of the three ages (if present) was identified as the estimated age (Minard and Dye 1998). If a mode was not apparent after three examinations, a fourth or fifth examination was conducted until an age could be assigned (Minard and Dye 1998).

Figure 10. Vemco Ltd. VR2 receiver used to detect movements of native char in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Figure 11. Attachment of Vemco Ltd. VR2 receiver used to detect movements of native char in the lower in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

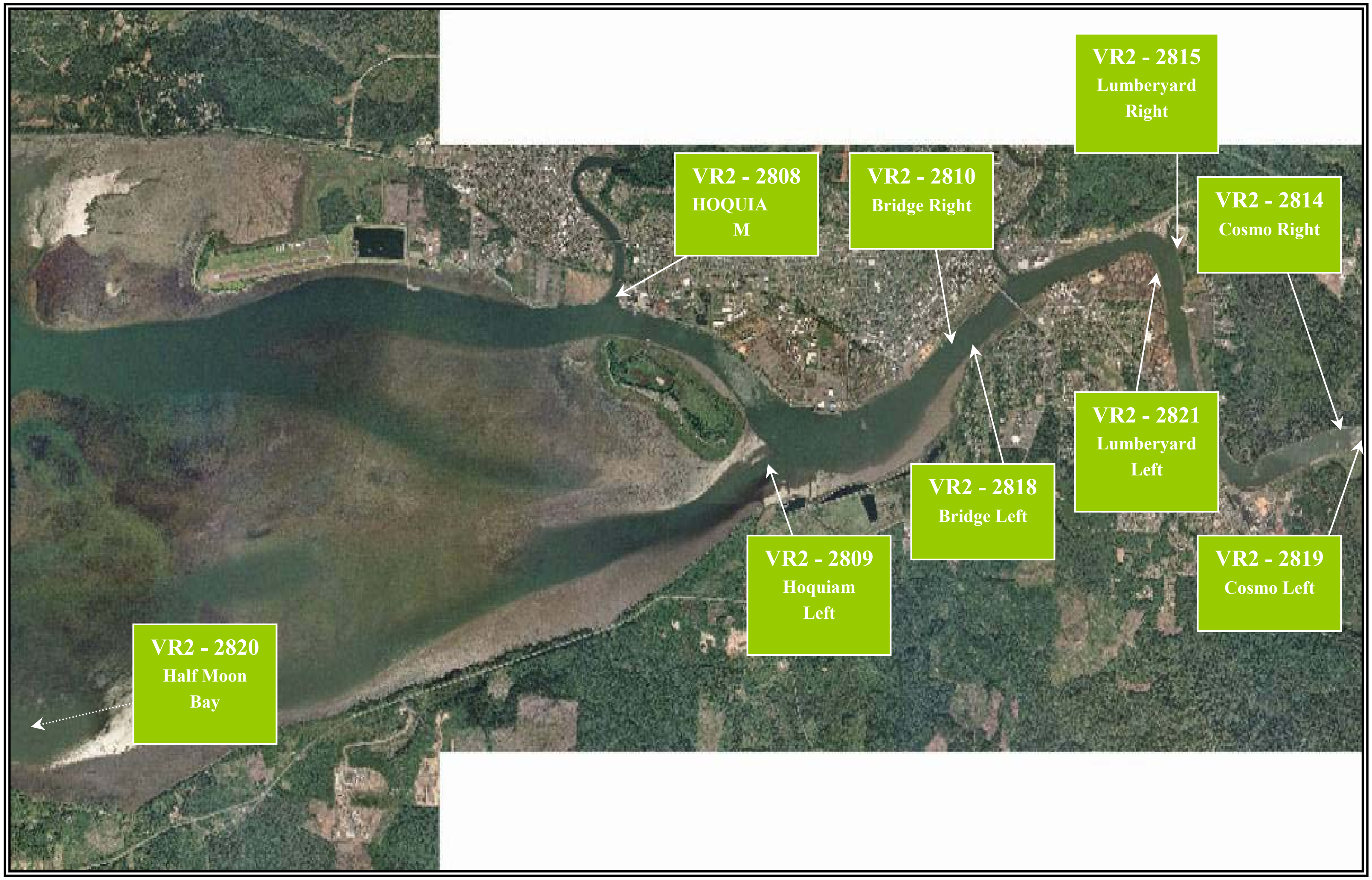

Figure 12. The location of nine (9) native char fixed acoustic monitoring sites in the lower Chehalis River/Grays Harbor, Washington, 2003-2005.

Fork length at age was back-calculated for the native char using the Fraser-Lee method. This method has been widely accepted (DeVries and Frie 1996) and is applicable when the relationship between fish length and annuli radius is not zero. The formula for this calculation is:

$$L_i = \frac{L_c - a}{S_c} S_i + a$$

where:
L_i = back-calculated length of the fish when the i^{th} annuli was formed,
L_c = fork length of the fish at capture,
S_c = radius of the scale at capture,
S_i = radius of the annuli at the i^{th} increment; and
a = intercept parameter.

There are multiple methods in which to determine the intercept parameter (a). The standard parameter (a) is calculated as the intercept of the regression for fish length at capture on scale radius at capture. However, in order for this regression to result in an accurate intercept, there must be a large sample size with a wide distribution of fish sizes/ages. A more recent approach, and the method used on the lower Chehalis River/Grays Harbor native char, is to generate a biologically determined intercept, defined as the fish length at which scale length equals zero. Juvenile native char swim-up fry in the Skagit River (FL=28-30 mm) have been captured with scales formed (C. Kraemer, WDFW retired, *pers. comm.*). An intercept parameter (a) of 30 was used to back-calculate length at age of native char in the lower Chehalis River/Grays Harbor.

3.6 WATER QUALITY MONITORING

During study period, water quality measurements were collected at the downstream, middle and upstream sites (Sites 1, 8, and 12) using a Hydrolab Quanta® backpack style water quality monitoring system. Salinity, water temperature, dissolved oxygen and pH were collected at these sites during both the day and night surveys. The Hydrolab Quanta® was calibrated the day previous to all sampling occasions. All fish and water quality data were entered electronically using MS Excel™ and cross-referenced with original field data forms for QA/QC purposes. All data analyses were conducted in MS Excel™, except if otherwise noted.

4. RESULTS

4.1 BEACH SEINE DATA

We conducted a total of 33 survey trips on the lower Chehalis River/Grays Harbor. Each trip consisted of one day and one night survey (seine haul) at each location resulting in a total of 784 seine hauls within the project area (mouth of Hoquiam River upstream to approximately Cosmopolis). A total of 27 different species or species assemblages were captured during the study period including six salmonids; Chinook, chum, and coho salmon, steelhead and cutthroat trout and native char (Table 5). More than 119,000 individuals (151.9 seine haul^{-1}) were captured, among them Peamouth chub (*Mylocheilus caurinus*), shiner perch, Pacific staghorn/prickly sculpin (*Cottus asper/Leptocottus armatus*), and gunnel/prickleback species (*Pholidae spp./Stichaeidae spp.*) were the most numerous non-salmonid species (Tables 6-11). Crabs (primarily dungeness [*Cancer magister*]) were the only invertebrate species enumerated; however, numerous shrimp (*Crangon spp.*) were observed.

4.1.1 Native char

All native char were captured in beach seine surveys, angling surveys hooked two char but they were not captured. One other native char was observed during angling surveys but were not hooked. Fifteen (15) native char were captured during the study periods; seven (47%) were captured from 7 March 2002 through 15 March 2002, one (7%) was captured on 19 June 2002, one was captured from 27 March through 23 April 2003, and six (40%) were captured from 19 February through 26 March 2004 (Table 11). No char were captured during the 2001 study period. Native char were evenly distributed throughout the study area; four char were captured at Survey Sites 11 (Bird Island) and 5 (Lakeside), while three were captured at Survey Site 7 (Top Foods), two at Survey Site 9 (Chip Mill), and one each at Survey Sites 3 (Big Stump) and 6 (Weyerhaeuser). Catch per unit effort for the lower Chehalis River was 0.02 native char ha^{-1}.

Fork lengths of native char ranged from 224 to 520 mm (mean FL=47 mm; std. dev.=83 mm). Native char were not captured upstream from the Big Stump (Site 3) (Figure 13). Six (6) native char were aged at 3+ (224-327 mm FL), six (6) char were 4+ (320-405 mm FL), one char was 5+ (382 mm FL) while two char were estimated at 6+ (475 and 520 mm FL) years of age (Table 7). The weights of native char ranged from 154-1,730 g (mean=602 g; std. dev.=467 g). The majority of the native char captured in the lower Chehalis River (73%)

were experiencing their first anadromous migration (X.1), three char (20%) appeared to be on their second migration to saltwater (X.2), while one char (7%) was on its third migration (X.3) to the Pacific Ocean (Table 12).

Seven (7) native char were surgically implanted with Vemco Ltd. 2L-R04K coded transmitters with random burst rates ranging from 40-120 seconds. Native char implanted with acoustic tags in the lower Chehalis had a minimum battery life of 585 days, for the most part lasting through the fall of 2005 (Table 13). The earliest appearance date within the project area was on 18 February, while the latest observation date was recorded on 30 June. Mean residence time within the project area (not including one battery failure) was 76.2 days (Table 14). The native char appeared to show a preference for the middle reach of the study area, extending from the Bridge stations upstream to the Lumberyard stations. Four native char made repeat voyages to the lower Chehalis River; one appearing in three consecutive seasons (Table 14). Native char were not detected at the Half Moon Bay fixed monitoring station (Figure 12).

Table 5. Common and scientific names of species captured in beach seine surveys conducted in the Chehalis River estuary, Washington 2001-2004.

Common Name	Scientific Name
Bay pipefish	*Syngnathus leptorhynchus*
Bluegill	*Lepomis macrochirus*
Chinook salmon	*Oncorhynchus tshawytscha*
Chum salmon	*O. keta*
Coho salmon	*O. kisutch*
Coastal cutthroat trout	*O. clarki clarki*
Dungeness crab	*Cancer magister*
Gunnel spp. (Gunnel spp. not differentiated from Prickleback spp.)	*Pholidae spp.* (gunnel) *Stichaeidae spp.* (prickleback)
Largescale sucker	*Catostomus macrocheilus*
Longnose dace	*Rhynichthys cataractae*
Native char	*Salvelinus malma/S. confluentus*
Northern anchovy	*Engraulis mordax*
Northern pikeminnow	*Ptychocheilus oregonensis*
Olympic mudminnow	*Nuvumbra hubbsi*
Pacific herring	*Clupea harengus*
Pacific tomcod	*Microgadus proximus*
Peamouth chub	*Mylocheilus caurinus*
Rainbow trout	*O. mykiss*
Redside shiner	*Richardsonius balteatus*
River lamprey	*Lampetra ayresi*
Sculpin spp. (Prickly not differentiated from Pacific Staghorn)	*Cottus asper* *Leptocottus armatus*
Shiner perch	*Cyamatogaster aggregata*
Smelt spp. (Longfin not differentiated from Surf)	*Spirinchus Thaleichthys* *Hypomesus pretiosus*
Sole spp. (English sole not differentiated from Sand sole or Pacific sanddab)	*Parophrys vetulus* *Pserttichthys melanostictus* *Citharichthys sordidus*
Starry flounder	*Platichthys stellatus*
Threespine stickleback	*Gasterosteus aculeatus*
Yellow perch	*Perca flavescens*

Table 6. Number of fish captured during beach seine surveys conducted at eleven survey sites in the lower Chehalis River/Grays Harbor, Washington, June-July 2001.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Total
B. Pipefish	0	2	0	0	0	1	0	0	0	1	0	-	4
Bluegill	0	0	0	0	0	0	0	0	0	0	0	-	0
Chinook salmon	8	6	56	50	55	42	52	97	129	90	84	-	669
Chum salmon	0	0	0	0	0	0	0	0	0	0	0	-	0
Coho salmon	0	0	0	1	0	0	0	2	2	2	2	-	9
Cutthroat trout	0	1	1	0	0	0	2	2	5	6	6	-	23
D. Crab	0	0	32	7	27	37	216	60	100	106	128	-	713
Gunnel spp.	0	1	56	13	2	14	190	71	65	6	24	-	442
L.N. Dace	0	0	0	0	0	0	0	0	0	0	0	-	0
L.S. Sucker	0	0	0	0	0	0	0	0	0	0	0	-	0
N. Anchovy	0	4	14	171	13	0	1,023	39	138	123	91	-	1,616
N. Pikeminnow	18	15	35	13	11	6	20	20	1	0	0	-	139
Native Char	0	0	0	0	0	0	0	0	0	0	0	-	0
O. Mudminnow	0	0	0	0	0	0	0	0	0	0	0	-	0
P. Herring	0	0	31	4	10	1	2	11	14	35	21	-	129
P. Tomcod	0	1	1	0	1	1	1	3	0	0	0	-	8
Peamouth chub	10	24	1,612	65	64	61	74	79	13	0	0	-	2,002
R. Lamprey	0	0	0	0	0	0	0	0	0	0	1	-	1
Rainbow trout	0	0	0	0	1	0	4	0	0	0	3	-	8
Redside shiner	0	0	0	0	0	0	0	0	0	0	0	-	0
S. Flounder	1	1	85	13	0	6	55	23	34	5	5	-	228
Sculpin spp.	13	21	462	51	89	122	164	103	64	24	38	-	1,151
Shiner Perch	55	230	1,789	470	240	403	1,389	1,479	740	395	2,693	-	9,883
Smelt spp.	27	71	162	174	214	307	210	198	420	621	413	-	2,817
Sole spp.	0	0	20	6	0	22	158	43	80	4	79	-	412
T.S. Stickleback	20	10	23	16	363	3	8	9	7	69	14	-	542
Y. Perch	0	0	0	0	0	0	0	0	0	0	0	-	0
Grand Total	152	387	4,379	1,054	1,090	1,026	3,568	2,239	1,812	1,487	3,602	N.S.	20,796

Table 7. Number of fish captured during beach seine surveys conducted at twelve survey sites in the lower Chehalis River/Grays Harbor, Washington, February-March and June-September 2002.

Species	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**Site 11**	**Site 12**	**Total**
B. Pipefish	2	0	3	0	0	2	0	4	1	0	7	0	19
Bluegill	1	0	0	0	0	1	0	0	0	0	0	0	2
Chinook salmon	25	55	89	92	68	56	114	93	116	145	127	0	980
Chum salmon	26	203	160	69	92	40	254	238	184	56	89	0	1,411
Coho salmon	0	3	2	2	1	7	3	14	4	0	1	0	37
Cutthroat trout	1	0	6	6	2	3	16	8	9	1	5	0	57
D. Crab	42	40	236	138	30	136	401	187	182	318	809	162	2,681
Gunnel spp.	104	398	376	616	37	108	1,567	445	447	88	218	0	4,404
L.N. Dace	0	0	0	0	0	0	0	0	0	0	0	0	0
L.S. Sucker	5	5	1	0	0	0	2	0	0	0	0	0	13
N. Anchovy	1	0	0	0	1	0	0	0	0	0	128	0	130
N. Pikeminnow	4	2	3	0	0	0	0	0	0	0	0	0	9
Native Char	0	0	0	0	1	1	2	0	1	1		2	8
O. Mudminnow	0	0	0	0	0	0	0	0	0	0	0	0	0
P. Herring	19	0	10	2	0	2	2	7	19	58	16	0	135
P. Tomcod	20	51	90	46	4	13	46	45	24	98	100	13	550
Peamouth chub	724	1,115	1,851	284	108	142	212	192	31	0	2	0	4,661
R. Lamprey	1	0	0	0	0	0	0	0	0	1	0	0	2
Rainbow trout	1	0	2	0	0	1	1	0	0	0	0	0	5
Redside shiner	1	0	0	0	0	0	0	0	0	0	0	0	1
S. Flounder	136	114	211	86	1	88	224	101	45	35	29	16	1,086
Sculpin spp.	604	886	1,000	393	162	415	855	417	262	166	321	0	5,481
Shiner Perch	3,593	3,121	3,900	2,955	921	1,793	5,172	3,379	2,174	1,671	1,624	5	30,308
Smelt spp.	105	10	113	14	18	124	162	62	90	78	155	3	934
Sole spp.	12	33	104	94	5	131	299	197	68	32	584	3	1,562
T.S. Stickleback	55	253	262	116	121	203	314	205	158	134	251	1	2,073
Y. Perch	0	1	2	0	0	0	0	1	0	0	0	0	4
Grand Total	5,482	6,290	8,421	4,913	1,572	3,266	9,646	5,595	3,815	2,882	4,466	205	56,553

Table 8. Number of fish captured during beach seine surveys conducted at twelve survey sites in the lower Chehalis River/Grays Harbor, Washington, March-April, June, and September 2003.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Total
B. Pipefish	0	0	0	1	0	0	0	0	6	0	1	0	8
Bluegill	0	0	0	0	0	0	0	0	0	0	0	0	0
Chinook salmon	342	209	455	308	201	212	751	343	486	137	136	97	3,677
Chum salmon	25	140	56	75	194	56	409	67	222	61	218	28	1,551
Coho salmon	81	58	90	44	56	27	108	32	69	3	17	1	586
Cutthroat trout	1	0	5	1	7		4	7	6	1	2	1	35
D. Crab	0	0	481	24	2	68	165	47	755	135	455	64	2,196
Gunnel spp.	10	4	140	24	0	24	59	52	230	29	99	12	683
L.N. Dace	0	0	0	0	0	0	0	1	0	0	0	0	1
L.S. Sucker	13	15	2	2	4	3	2	0	0	0	0	1	42
N. Anchovy	0	0	9	0	0	2	1	1	12	3	0	33	61
N. Pikeminnow	3	1	3	0	0	0	1	0	0	0	0	0	8
Native Char	0	0	1	0	0	0	0	0	0	0	0	0	1
O. Mudminnow	0	0	0	0	0	0	0	0	0	0	0	0	0
P. Herring	10	13	13	1	2	4	2	5	22	9	4	5	90
P. Tomcod	0	0	10	1	0	6		9	58	3	0	1	88
Peamouth chub	336	920	550	230	108	116	223	241	56	0	0	0	2,780
R. Lamprey	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainbow trout	2	0	5	3	18	4	49	1	8	7	1	1	99
Redside shiner	0	0	0	0	0	0	0	0	0	0	0	0	0
S. Flounder	103	61	122	45	2	47	135	76	119	34	56	31	831
Sculpin spp.	163	178	478	477	103	195	516	454	532	90	240	100	3,526
Shiner Perch	721	180	1,747	296	32	207	882	480	1,487	106	270	164	6,572
Smelt spp.	4	6	17	8	1	7	10	13	29	9	13	6	123
Sole spp.	1	1	22	19	0	31	90	40	152	28	189	20	593
T.S. Stickleback	114	103	354	256	57	186	249	132	269	120	128	120	2,088
Y. Perch	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	1,929	1,889	4,560	1,815	787	1,195	3,656	2,001	4,518	775	1,829	685	25,639

Table 9. Number of fish captured during beach seine surveys conducted at twelve survey sites in the lower Chehalis River/Grays Harbor, Washington, February-March 2004.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Total
B. Pipefish	0	0	0	0	0	1	0	0	0	0	0	0	1
Bluegill	0	0	0	0	0	0	0	0	0	0	0	0	0
Chinook salmon	69	119	625	75	333	67	440	13	94	10	2	18	1,865
Chum salmon	314	212	681	331	2,536	67	595	744	714	1,679	2	595	8,470
Coho salmon	0	0	4	0	1	2	5	3	1	0	0	0	16
Cutthroat trout	0	0	0	0	1	0	0	0	0	0	0	0	1
D. Crab	1	8	0	0	0	0	2	1	23	4	61	136	236
Gunnel spp.	3	4	0	0	0	9	9	2	13	2	14	30	86
L.N. Dace	0	0	0	0	0	0	0	0	0	0	0	0	0
L.S. Sucker	0	0	2	1	2	1	3	0	0	0	0	0	9
N. Anchovy	0	0	0	0	0	0	0	0	0	0	0	0	0
N. Pikeminnow	0	0	0	0	1	0	0	0	0	0	0	0	1
Native Char	0	0	0	0	3	0	1	0	1	1	0	0	6
O. Mudminnow	0	0	1	0	0	0	0	0	0	0	0	0	1
P. Herring	0	9	13	2	0	1	4	0	2	0	0	0	31
P. Tomcod	0	1	1	3	6	15	14	30	174	14	2	80	340
Peamouth chub	0	0	366	222	60	81	294	80	26	10	0	2	1,141
R. Lamprey	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainbow trout	0	0	0	0	0	0	2	2	0	0	0	0	4
Redside shiner	0	0	0	0	0	0	0	0	0	0	0	0	0
S. Flounder	14	12	25	3	0	17	22	12	31	10	1	9	156
Sculpin spp.	34	9	187	304	87	154	753	310	459	20	8	29	2,354
Shiner Perch	1	0	6	0	9	9	16	7	17	2	0	8	75
Smelt spp.	195	68	43	11	13	24	10	26	52	24	0	24	490
Sole spp.	5	0	2	0	0	5	0	3	4	3	1	18	41
T.S. Stickleback	11	38	43	19	6	10	16	7	16	418	4	252	840
Y. Perch	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	647	480	1,999	971	3,058	463	2,186	1,240	1,627	2,197	95	1,201	16,164

Table 10. Number of fish captured during beach seine surveys conducted at twelve survey sites in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Total
B. Pipefish	2	2	3	1		4		4	7	1	8	0	32
Bluegill	1	0	0	0	0	0	0	0	0	0	0	0	1
Chinook salmon	444	389	1,225	525	657	377	1,357	546	825	382	349	115	7,191
Chum salmon	365	555	897	475	2,822	163	1,258	1,049	1,120	1,796	309	623	11,432
Coho salmon	81	61	96	47	58	36	116	51	76	5	20	1	648
Cutthroat trout	2	1	12	7	10	3	22	17	20	8	13	1	116
D. Crab	43	48	749	169	59	241	784	295	1,060	563	1,453	362	5,826
Gunnel spp.	117	407	572	653	40	155	1,825	570	755	125	355	42	5,616
L.N. Dace	0	0	0	0	0	0	0	1	0	0	0	0	1
L.S. Sucker	18	20	5	3	6	4	7		0	0	0	1	64
N. Anchovy	1	4	23	171	14	2	1,024	40	150	126	219	33	1,807
N. Pikeminnow	25	18	41	13	12	6	21	20	1	0	0	0	157
Native Char	0	0	1	0	4	1	3	0	2	2	0	2	15
O. Mudminnow	0	0	1	0	0	0	0	0	0	0	0	0	1
P. Herring	29	22	67	9	12	8	10	23	57	102	41	5	385
P. Tomcod	20	53	102	50	11	35	61	87	256	115	102	94	986
Peamouth chub	1,070	2,059	4,379	801	340	400	803	592	126	10	2	2	10,584
R. Lamprey	1	0	0	0	0	0	0	0	0	1	1	0	3
Rainbow trout	3	0	7	3	19	5	56	3	8	7	4	1	116
Redside shiner	1	0	0	0	0	0	0	0	0	0	0	0	1
S. Flounder	254	188	443	147	3	158	436	212	229	84	91	56	2,301
Sculpin spp.	814	1,094	2,127	1,225	441	886	2,288	1,284	1,317	300	607	129	12,512
Shiner Perch	4,370	3,531	7,442	3,721	1,202	2,412	7,459	5,345	4,418	2,174	4,587	177	46,838
Smelt spp.	331	155	335	207	246	462	392	299	591	732	581	33	4,364
Sole spp.	18	34	148	119	5	189	547	283	304	67	853	41	2,608
T.S. Stickleback	200	404	682	407	547	402	587	353	450	741	397	373	5,543
Y. Perch	0	1	2	0	0	0	0	1	0	0	0	0	4
Grand Total	8,210	9,046	19,359	8,753	6,508	5,949	19,056	11,075	11,772	7,341	9,992	2,091	119,152

Table 11. Catch per unit effort (no ha^{-1}) of fish captured during beach seine surveys conducted at twelve survey sites in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Species	1	2	3	4	5	6	7	8	9	10	11	12	Total
Chinook salmon	7.17	6.28	19.78	8.48	10.61	6.09	21.91	8.82	13.32	6.17	5.63	1.86	116.10
Chum salmon	5.89	8.96	14.48	7.67	45.56	2.63	20.31	16.94	18.08	29.00	4.99	10.06	184.58
Coho salmon	1.31	0.98	1.55	0.76	0.94	0.58	1.87	0.82	1.23	0.08	0.32	0.02	10.46
Cutthroat trout	0.03	0.02	0.19	0.11	0.16	0.05	0.36	0.27	0.32	0.13	0.21	0.02	1.87
Native char	0.00	0.00	0.02	0.00	0.06	0.02	0.05	0.00	0.03	0.03	0.00	0.03	0.24
Rainbow trout	0.05	0.00	0.11	0.05	0.31	0.08	0.90	0.05	0.13	0.11	0.06	0.02	1.87
Sub total	*15.45*	*18.24*	*39.13*	*21.07*	*62.64*	*15.45*	*52.40*	*34.90*	*42.11*	*45.52*	*22.22*	*24.00*	
B. Pipefish	0.03	0.03	0.05	0.02	0.00	0.06	0.00	0.06	0.11	0.02	0.13	0.00	0.52
Bluegill	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
D. Crab	0.69	0.77	12.09	2.73	0.95	3.89	12.66	4.76	17.11	9.09	23.46	5.84	94.06
Gunnel spp.	1.89	6.57	9.24	10.54	0.65	2.50	29.47	9.20	12.19	2.02	5.73	0.68	90.67
L.N. Dace	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02
L.S. Sucker	0.29	0.32	0.08	0.05	0.10	0.06	0.11	0.00	0.00	0.00	0.00	0.02	1.03
N. Anchovy	0.02	0.06	0.37	2.76	0.23	0.03	16.53	0.65	2.42	2.03	3.54	0.53	29.18
N. Pikeminnow	0.40	0.29	0.66	0.21	0.19	0.10	0.34	0.32	0.02	0.00	0.00	0.00	2.53
O. Mudminnow	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
P. Herring	0.47	0.36	1.08	0.15	0.19	0.13	0.16	0.37	0.92	1.65	0.66	0.08	6.22
P. Tomcod	0.32	0.86	1.65	0.81	0.18	0.57	0.98	1.40	4.13	1.86	1.65	1.52	15.92
Peamouth chub	17.28	33.24	70.70	12.93	5.49	6.46	12.96	9.56	2.03	0.16	0.03	0.03	170.89
R. Lamprey	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.05
Redside shiner	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
S. Flounder	4.10	3.04	7.15	2.37	0.05	2.55	7.04	3.42	3.70	1.36	1.47	0.90	37.15
Sculpin spp.	13.14	17.66	34.34	19.78	7.12	14.31	36.94	20.73	21.26	4.84	9.80	2.08	202.01
Shiner perch	70.56	57.01	120.16	60.08	19.41	38.94	120.43	86.30	71.33	35.10	74.06	2.86	756.23
Smelt spp.	5.34	2.50	5.41	3.34	3.97	7.46	6.33	4.83	9.54	11.82	9.38	0.53	70.46
Sole spp.	0.29	0.55	2.39	1.92	0.08	3.05	8.83	4.57	4.91	1.08	13.77	0.66	42.11
T.S. Stickleback	3.23	6.52	11.01	6.57	8.83	6.49	9.48	5.70	7.27	11.96	6.41	6.02	89.50
Y. Perch	0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.06
Sub Total	*118.11*	*129.81*	*276.43*	*124.26*	*47.44*	*86.61*	*262.27*	*151.91*	*156.95*	*83.01*	*150.11*	*21.76*	
Grand Total	***133.56***	***148.05***	***315.56***	***145.32***	***110.08***	***102.05***	***314.67***	***186.81***	***199.07***	***128.53***	***172.33***	***45.76***	

Table 12. Capture date, site name, fork length (mm), weight (g), sex, and estimated age of native char captured during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, Washington, 2001-2004 (* denoting implanted with acoustic transmitter).

Char No.	Capture Date	Site No.	Site Name	Strata	Fork Length (mm)	Weight (g)	Sex	Est. Age
16	7 March 02	6	Weyerhaeuser	Day	242	251	m	3+
17	7 March 02	11	Bird Island	Day	326	331	m	3+
18	8 March 02	5	Lakeside Ind.	Night	224	249	f	3+
19	8 March 02	11	Bird Island	Night	296	305	f	3+
20	15 March 02	7	Top Foods	Night	231	154	f	3+
21	15 March 02	9	Chip Mill	Night	372	460	f	4+
22	15 March 02	7	Top Foods	Night	388	600	f	4+
23	19 June 02	11	Bird Island	Night	520	1,730	m	6+
24*	14 April 03	3	Big Stump	Night	405	950	m	4+
25*	19 February 04	11	Bird Island	Night	475	1,550	m	6+
26*	19 February 04	9	Chip Mill	Night	327	450	m	3+
27*	19 February 04	7	Top Foods	Night	363	525	m	4+
28*	4 March 04	5	Lakeside Ind.	Day	340	400	m	4+
29*	3 March 04	5	Lakeside Ind.	Day	382	700	m	5+
30*	25 Mar 04	5	Lakeside Ind.	Day	320	375	f	4+

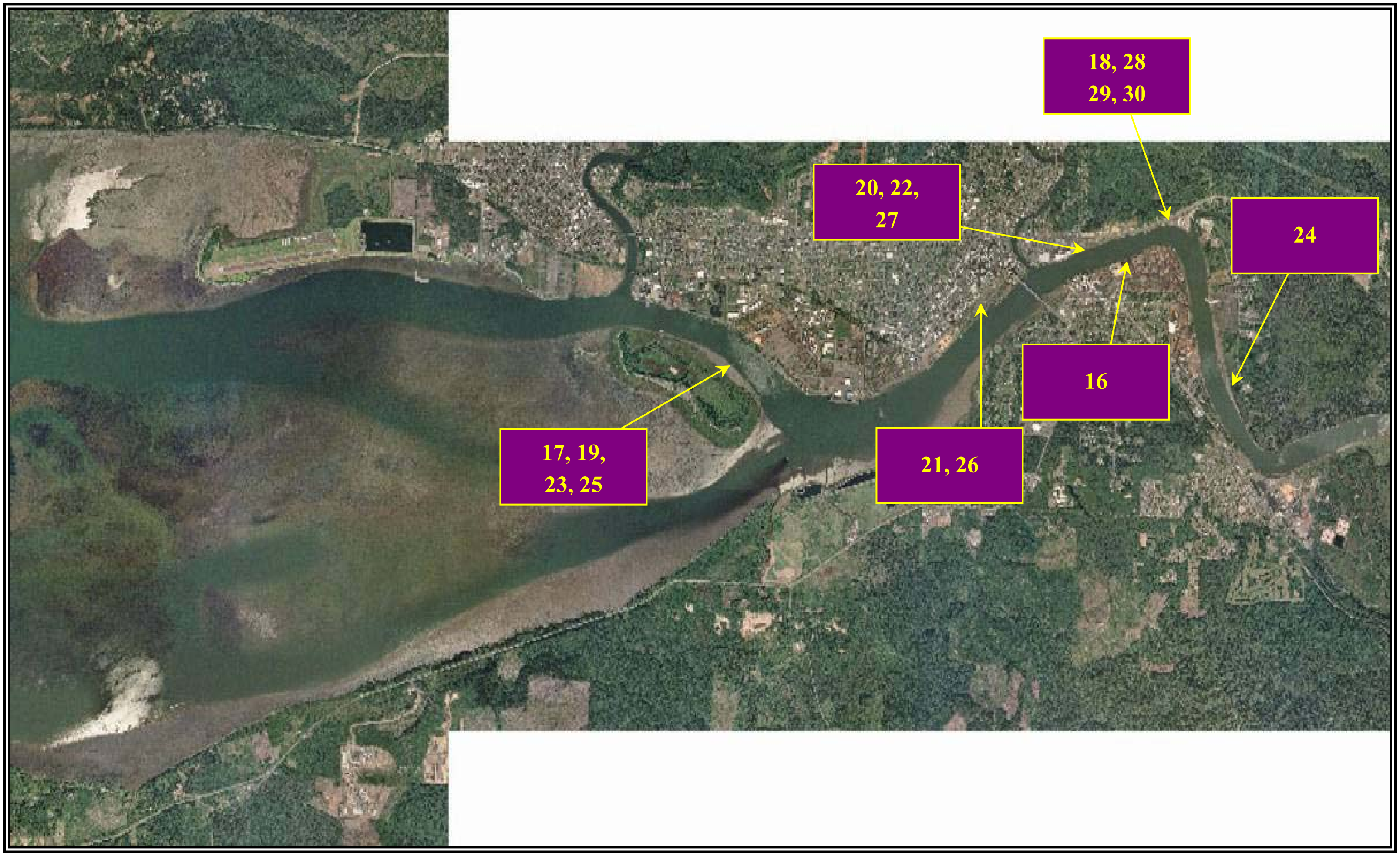

Figure 13. The location of 15 native char captures during beach seine surveys conducted in the Chehalis River/Grays Harbor Federal Navigation Channel, Washington, 2001-2004.

Table 13. Char number, fork length (mm), estimated age, life history strategy, and back-calculated length at age of native char captured during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, Washington, 2001-2004 (* denoting implanted with acoustic transmitter).

Char No.	Fork Length (mm)	Est. Age	Est. Life History	Back Calculated Length at Age					
				1	2	3	4	5	6
16	242	3+	2.1	88.4	138.5	201.9			
17	326	3+	2.1	98.5	187.2	306.6			
18	224	3+	2.1	80.9	140.9	213.4			
19	296	3+	2.1	102.0	160.7	290.0			
20	231	3+	2.1	72.8	141.4	219.1			
21	372	4+	2.2	97.8	156.7	223.9	327.6		
22	388	4+	3.1	91.9	149.2	267.0	381.6		
23	520	6+	3.3	111.6	157.0	235.4	289.0	383.9	487.0
24*	405	4+	2.2	128.6	186.2	324.4	393.5		
25*	475	6+	4.2	76.6	135.7	202.0	275.8	364.3	438.1
26*	327	3+	2.1	100.5	166.6	289.3			
27*	363	4+	3.1	96.2	158.4	229.6	318.5		
28*	340	4+	3.1	71.9	132.2	206.0	299.8		
29*	382	5+	4.1	76.0	127.0	185.3	250.9	338.3	
30*	320	4+	3.1	92.4	151.4	227.3	303.1		

Table 14. Capture date, site name, fork length (mm), weight (g), acoustic tag type, and minimum expected battery life of transmitter surgically implanted in native char captured during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, Washington, 2003-2004.

Char No.	Capture Date	Site Name	Strata	Fork Length (mm)	Weight (g)	Tag Type	Est. Life Expectancy
24	14 April 03	Big Stump	Night	405	950	V8-2L	21 Nov 04
25	19 February 04	Bird Island	Night	475	1,550	V8-2L	27 September 05
26	19 February 04	Chip Mill	Night	327	450	V8-2L	27 September 05
27	19 February 04	Top Foods	Night	363	525	V8-2L	27 September 05
28	4 March 04	Lakeside Ind.	Day	340	400	V8-2L	14 September 05
29	3 March 04	Lakeside Ind.	Day	382	700	V8-2L	13 September 05
30	25 Mar 04	Lakeside Ind.	Day	320	375	V8-2L	22 August 05

Table 15. Char number, date of capture, first and last known locations, residence period, and other known locations of native char in lower Chehalis River/Grays Harbor Federal Navigation Channel, Washington, 2003-2004 (italics indicate consecutive year observations).

Char No.	Capture Date	First Date Recorded in Project Area	Last Date Recorded in Project Area	Residence Time in Project Area	Comments
24	14 April 03	14 April 2003 (Bridge Right)	3 June 2003 (Hoquiam Right)	50 Days	Majority of time spent near Lumberyard – Recaptured on 3 Jan 2004 on Upper Hoh River
24	*14 April 03*	*10 April 2004 (Hoquiam Right)*	*30 May 2004 (Hoquiam Right)*	*52 Days*	*Majority of time spent near Lumberyard*
24	*14 April 03*	*4 April 2005 (Bridge Left)*	*10 April 2005 (Lumberyard Left)*	*7 Days*	*Majority of time spent at Lumberyard (transmitter battery apparently died)*
25	19 Feb 04	23 February 2004 (Bridge Left)	15 May 2004 (Hoquiam Right)	83 Days	Majority of time spent near Lumberyard with additional residence near Cosmo stations
25	*19 Feb 04*	*20 February 2005 (Hoquiam Right)*	*18 May 2005 (Hoquiam Left)*	*88 Days*	*Majority of time spent near Lumberyard stations*
26	19 Feb 04	19 February 2004 (Bridge Right)	10 April 2004 (Hoquiam Left)	51 Days	Majority of time spent near Lumberyard stations
27	19 Feb 04	20 February 2004 (Bridge Left)	15 April 2004 (Hoquiam Right)	56 Days	Majority of time spent near Hoquiam Right Bank with some observations in lower Hoquiam River
27	*19 Feb 04*	*18 February 2005 (Bridge Left)*	*22 April 2005 (Hoquiam Left)*	*63 Days*	*Majority of time spent near Hoquiam and Bridge stations*
28	4 March 04	4 March 2004 (Bridge Right)	30 June 2004 (Hoquiam Right)	118 Days	Majority of time spent between Lumberyard and Bridge
29	4 March 04	4 March 2004 (Bridge Right)	27 June 2004 (Hoquiam Right)	115 Days	Majority of time spent between Lumberyard and Bridge
29	*4 March 04*	*22 February 2005 (Hoquiam Left)*	*17 May 2005 (Hoquiam Right)*	*85 Days*	*Majority of time spent near Lumberyard stations Recaptured on 10 Jan 2006 Hoh River*
30	25 Mar 04	31 March 2004 (Bridge Right)	10 June 2004 (Hoquiam Right)	77 Days	Majority of time spent between Lumberyard and Bridge with time spent upstream of Lumberyard

4.1.2 Salmonids

A total of 19,518 salmonids were captured during the 2001-2004 beach seine surveys conducted in the lower Chehalis River/Grays Harbor (Tables 6-10; Figure 14). Juvenile chum salmon were the most numerous salmonid captured (N=11,432; 59%) followed by juvenile Chinook salmon (N=7,191, 37%). The remaining salmonids in order of decreasing capture frequency were coho salmon (N=648; 3%), of cutthroat trout (N=116 1%), rainbow trout (N=116; 1%), and native char (N=15; <0.1%).

Chum fry were only captured during the February-March study period, with peak capture periods during the first week of March. Mean Chinook capture frequency increased steadily from the initial surveys, typically conducted in February, through June and early July, decreasing from there until the last survey was conducted in September. Small numbers of coho fry were captured from mid-March to mid-July. The majority (N=110, 95%) of the captured cutthroat trout were considered overyearling fish (>150 mm FL) the remaining six were considered juvenile. Rainbow trout were subjectively classified as overyearling (N=107; FL=275 mm) or adult (N=9; FL=570 mm) based on their length frequencies. Overall, juvenile salmonid capture indices peaked at Site 5 (CPUE=9.61), Site 7 (CPUE=7.57), and Site 3 (CPUE=6.02) (Figure 15) corresponding to the middle reach of the study area (Figure 3; Tables 6-10).

4.1.3 Other Species

Shiner perch were by far the most prolific species captured (N=40,191; 52%), followed by peamouth chub (N=6,663; ~1%) and sculpin *spp.* (primarily Pacific staghorn sculpin) (N=6,632; ~1%) (Tables 6-10; Figure 16). More individuals were captured during the night surveys (N=55,795; 56%) compared to daytime surveys (N=43,839; 44%). In general, the summer study period (June-September) was more productive than the February-March study period (Tables 6-10). Of the more than 99,000 individuals captured during the beach seine surveys conducted in the lower Chehalis River/Grays Harbor, the Top Foods (Site 7) and Big Stump (Site 3) were the most productive individual sites with 13,214 (~17% of total) and 12,798 (~16% of total) individuals captured, respectively (Table 10). Lakeside Industries (Site 5) was the least productive of the sites surveyed with only 2,662 individuals captured (Figure 17).

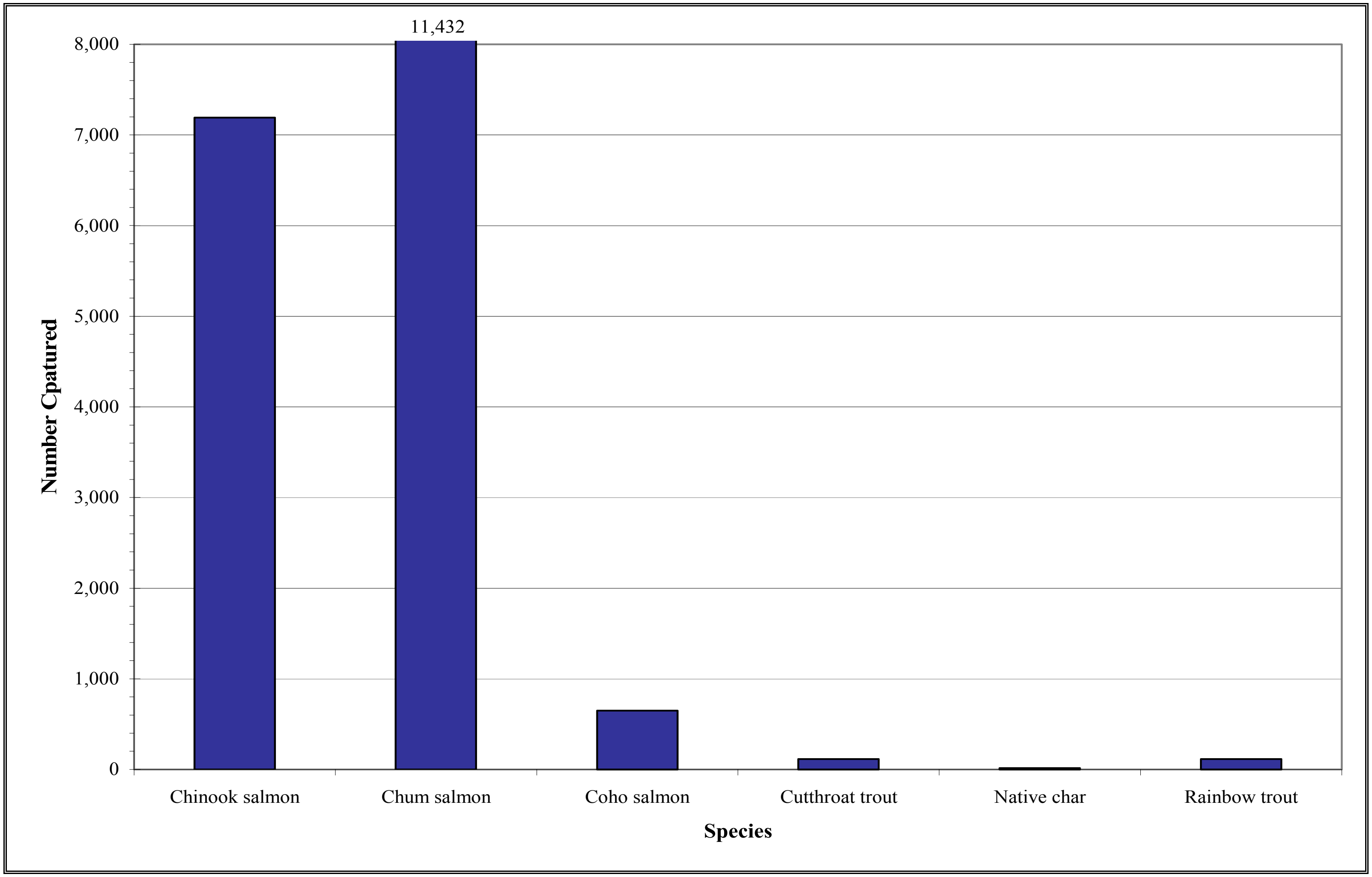

Figure 14. Number of salmonids captured during beach seine surveys conducted in the Chehalis River/Grays Harbor Federal Navigation Channel, Washington, 2001-2004.

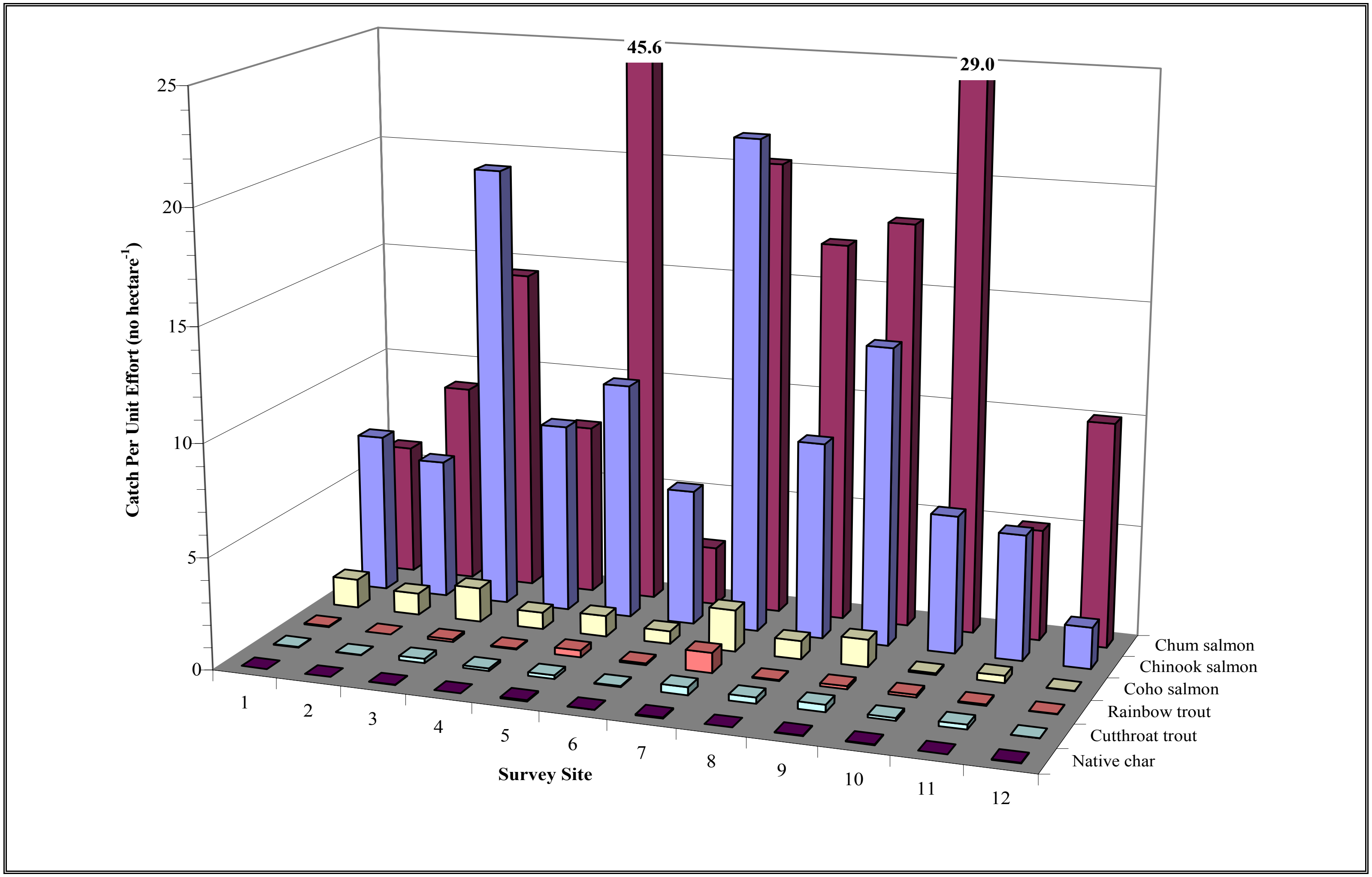

Figure 15. Mean catch per unit effort (no. ha^{-1}) indices of salmonids captured during beach seine surveys conducted in the Chehalis River/Grays Harbor Federal Navigation Channel, Washington, 2001-2004.

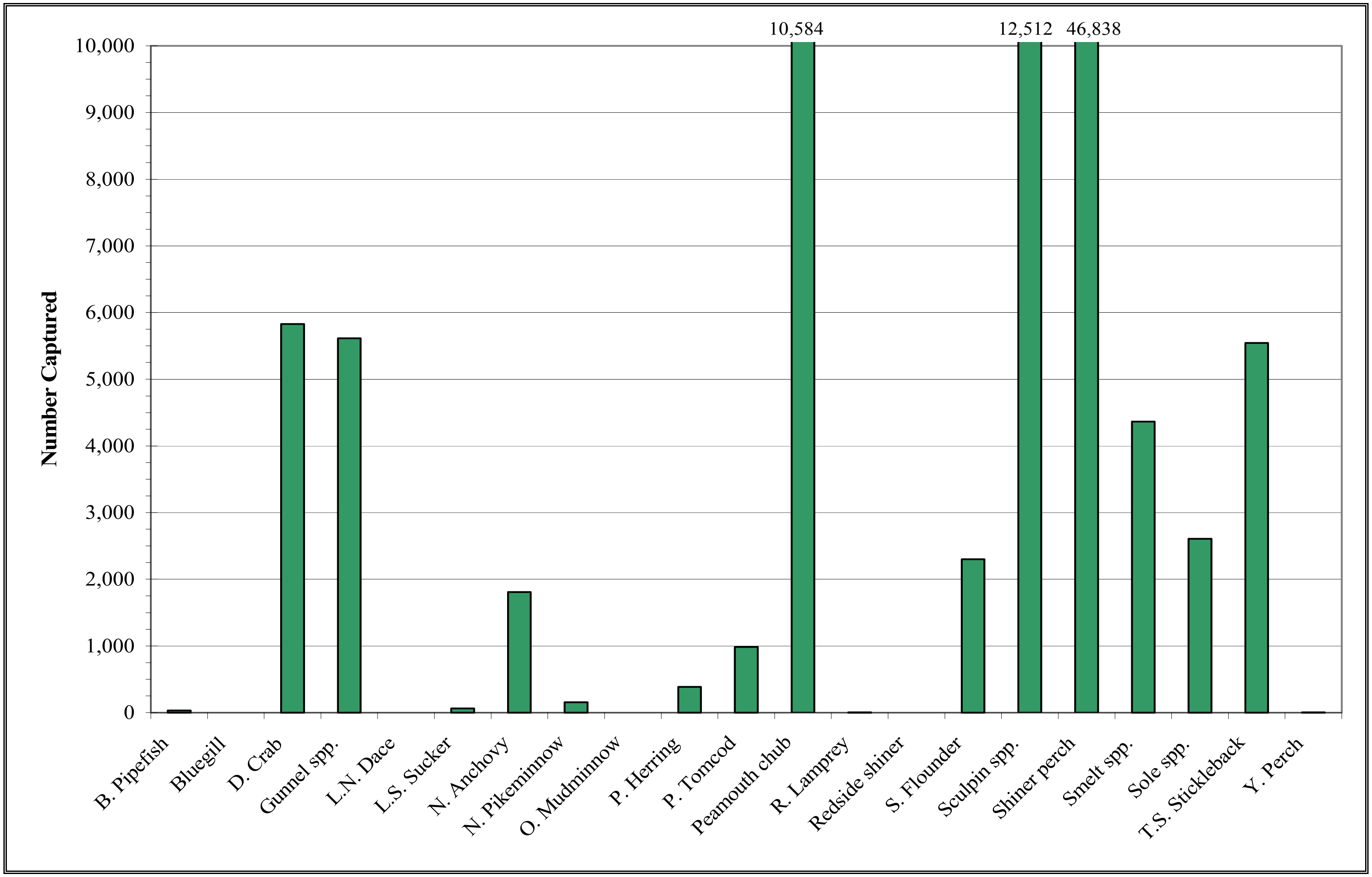

Figure 16. Number of other fish species captured during beach seine surveys conducted in the Chehalis River/Grays Harbor Federal Navigation Channel, Washington, 2001-2004.

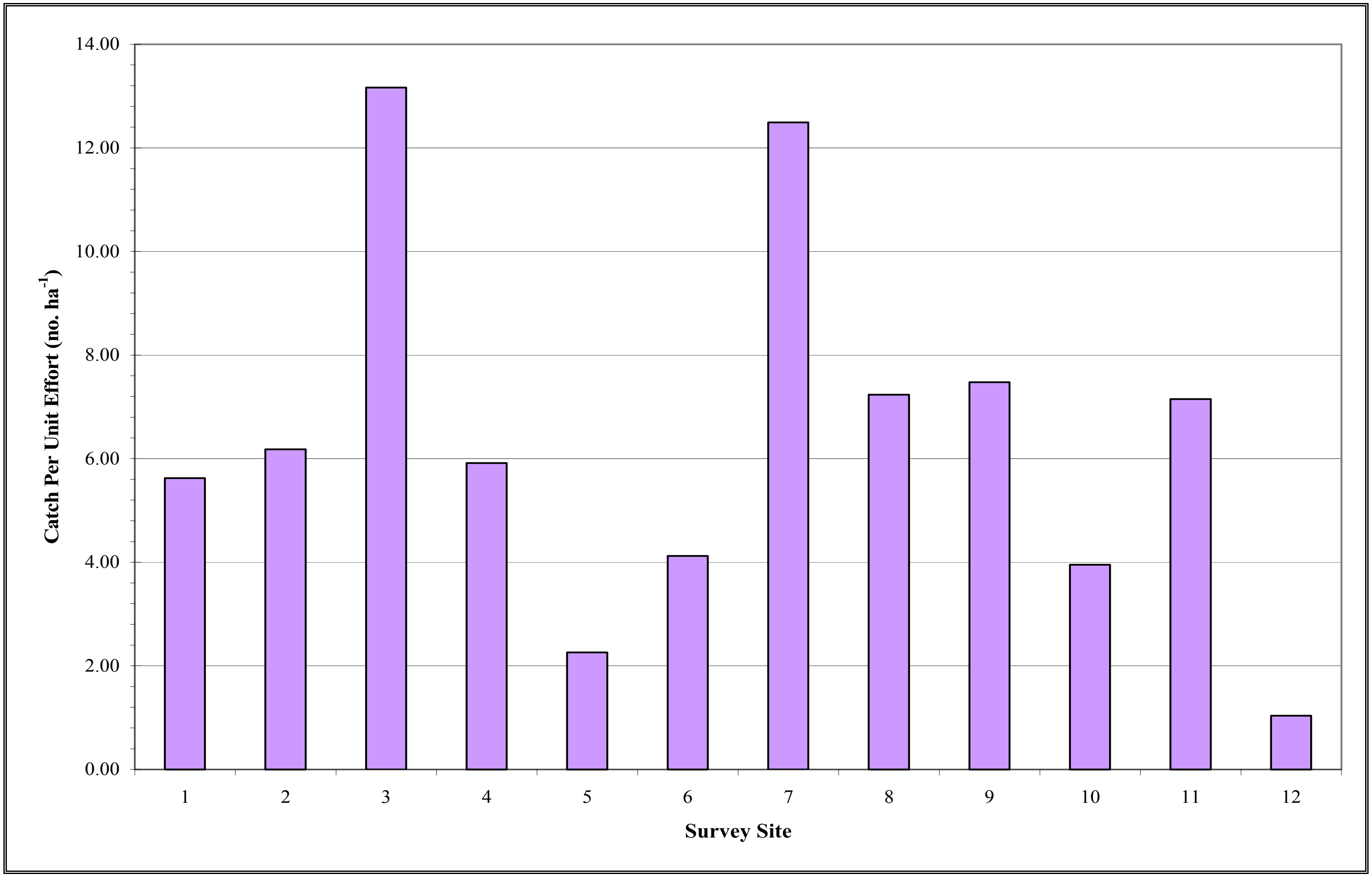

Figure 17. Mean catch per unit effort (no. ha^{-1}) indices of all other fish species captured during beach seine surveys conducted in the Chehalis River/Grays Harbor Federal Navigation Channel, Washington, 2001-2004.

4.2 WATER QUALITY DATA

Beginning in the summer study period, water temperature, pH, dissolved oxygen and salinity were collected at Otterville (Site 1), Boat Launch (Site 8), and the Hoquiam River (Site 12) (Table 16). Water quality measurements are not available for the night surveys conducted on 19 June and 16 August 2002 because of mechanical failure. Water temperatures were recorded on those dates with hand-held thermometers. Water quality parameters were strongly influenced by tidal cycles in the lower Chehalis River/Grays Harbor. At low tide, the water quality parameters of the lower Chehalis River are the dominant influence, while the incoming seawater largely controls the water quality on an incoming tide (Tables 16 and 17). Mean daily discharge in the lower Chehalis River was greater during the spring study period (February-March) than during the summer (June-September) study period. Spring discharge ranged from approximately 10,000 to 35,000 cfs and summer discharge was generally less than 2,000 cfs during the 2002 study period (US Geological Survey; online data).

Table 16. Site name, date, survey strata, time, tide, pH, salinity, temperature and dissolved oxygen concentration measured during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, 2002-2004.

Name	Date	Strata	Time	Tide	pH	Salinity (ppt)	Temp (C)	DO (mg/L)
Otterville	18-Jun	Day	08:30	Ebb	7.99	8.33	16.81	8.72
Boat Launch	18-Jun	Day	11:40	Ebb	8.38	10.77	16.74	9.14
Hoquiam River	18-Jun	Day	01:10	Ebb	8.47	15.11	16.84	11.31
Otterville	19-Jun	Night	01:30	Ebb			16.1	
Boat Launch	19-Jun	Night	23:30	Ebb			16.1	
Hoquiam River	19-Jun	Night	21:15	Ebb			16.1	
Otterville	24 Jun	Day	08:00	Flood	8.29	6.41	17.31	9.03
Boat Launch	24-Jun	Day	11:00	Flood	8.53	6.22	17.95	9.24
Hoquiam River	24-Jun	Day	12:20	Flood	8.39	10.28	17.40	9.41
Otterville	25-Jun	Night	12:00	Flood	8.48	5.76	17.99	8.87
Boat Launch	25-Jun	Night	20:45	Flood	8.56	5.19	18.04	9.91
Hoquiam River	25-Jun	Night	19:40	Flood	8.79	14.40	17.74	10.63
Otterville	10-Jul	Day	08:30	Flood	7.40	1.47	18.27	8.61
Boat Launch	10-Jul	Day	10:50	Flood	7.19	7.24	17.97	9.15
Hoquiam River	10-Jul	Day	12:00	Flood	7.85	15.68	19.00	8.05
Otterville	11-Jul	Night	23:20	Flood	7.64	8.77	18.00	8.90
Boat Launch	11-Jul	Night	21:15	Flood	7.68	8.16	18.14	9.55
Hoquiam River	11-Jul	Night	20:00	Ebb	7.63	16.85	17.85	9.15
Otterville	24-Jul	Day	08:00	Ebb	7.88	2.41	20.49	9.27
Boat Launch	24-Jul	Day	10:50	Flood	7.86	8.98	19.79	8.39
Hoquiam River	24-Jul	Day	12:00	Flood	8.00	18.08	19.00	9.00
Otterville	25-Jul	Night	23:50	Flood	7.93	8.08	20.01	8.03
Boat Launch	25-Jul	Night	21:20	Flood	7.97	10.05	19.71	8.32
Hoquiam River	25-Jul	Night	20:15	Flood	8.04	19.42	18.50	8.75
Otterville	15-Aug	Day	07:00	Flood	7.45	10.68	18.92	8.22
Boat Launch	15-Aug	Day	09:40	Ebb	7.77	15.14	18.50	7.69
Hoquiam River	15-Aug	Day	10:50	Ebb	7.97	19.55	18.29	8.24
Otterville	16-Aug	Night	02:10	Ebb			18.5	
Boat Launch	16-Aug	Night	23:50	Ebb			18.5	
Hoquiam River	16-Aug	Night	21:30	Flood			18.5	
Otterville	29-Aug	Day	12:40	Flood	7.35	9.66	19.07	8.06
Boat Launch	29-Aug	Day	10:40	Ebb	7.73	11.31	18.66	8.87
Hoquiam River	29-Aug	Day	09:30	Ebb	7.65	17.58	17.90	8.71
Otterville	30-Aug	Night	22:20	Ebb	7.65	12.85	18.32	7.80
Boat Launch	30-Aug	Night	20:05	Ebb	7.65	16.93	18.33	9.47
Hoquiam River	30-Aug	Night	18:30	Ebb	8.00	22.88	17.69	10.35
Otterville	12-Sep	Day	02:20	Flood	7.69	6.48	18.22	8.68
Boat Launch	12-Sep	Day	12:00	Flood	7.63	11.43	17.77	9.50
Hoquiam River	12-Sep	Day	09:50	Flood	7.66	11.12	17.52	9.40
Otterville	13-Sep	Night	22:00	Ebb	7.86	11.30	18.12	8.72
Boat Launch	13-Sep	Night	19:40	Ebb	8.03	18.78	17.58	11.36
Hoquiam River	13-Sep	Night	18:20	Ebb	7.98	24.89	16.70	10.35
Otterville	26-Sep	Day	09:20	Ebb	7.32	7.90	16.77	8.69

Table 16. Site name, date, survey strata, time, tide, pH, salinity, temperature and dissolved oxygen concentration measured during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, 2002-2004.

Name	Date	Strata	Time	Tide	pH	Salinity (ppt)	Temp (C)	DO (mg/L)
Boat Launch	26-Sep	Day	11:40	Flood	7.47	11.15	16.64	8.87
Hoquiam River	26-Sep	Day	12:45	Flood	7.77	19.10	16.68	8.68
Otterville	27-Sep	Night	22:20	Ebb	7.33	7.43	17.45	10.05
Boat Launch	27-Sep	Night	19:50	Ebb	7.74	17.15	16.38	8.61
Hoquiam River	27-Sep	Night	18:30	Ebb	7.84	22.77	15.98	7.25
Otterville	27-Mar	Day	9:20	Ebb	6.75	0.03	8.85	5.77
Boat Launch	27-Mar	Day	11:35	Ebb	7.11	0.55	8.86	6.60
Hoquiam River	27-Mar	Day	12:45	Ebb	7.24	2.41	9.38	6.60
Otterville	28-Mar	Night	22:10	Flood	6.93	0.00	8.70	6.20
Boat Launch	28-Mar	Night	19:50	Flood	7.09	0.16	8.99	5.29
Hoquiam River	28-Mar	Night	18:30	Flood	7.09	2.39	9.20	5.19
Otterville	3-Apr	Day	12:00	Flood	7.14	3.39	9.00	6.31
Boat Launch	3-Apr	Day	9:10	Flood	7.09	4.55	9.21	5.89
Hoquiam River	3-Apr	Day	8:00	Flood	7.11	8.93	8.75	5.98
Otterville	4-Apr	Night	22:45	Flood	7.22	9.13	8.50	6.01
Boat Launch	4-Apr	Night	20:20	Flood	9.55	12.13	9.17	7.21
Hoquiam River	4-Apr	Night	18:50	Ebb	7.35	0.06	9.33	7.33
Otterville	8-Apr	Night	23:30	Ebb	7.24	0.06	9.82	5.80
Boat Launch	8-Apr	Night	20:30	Ebb	7.55	0.75	8.82	5.85
Hoquiam River	8-Apr	Night	18:30	Ebb	7.16	0.76	9.57	7.56
Otterville	9-Apr	Day	7:40	Ebb	7.45	0.34	8.63	6.65
Boat Launch	9-Apr	Day	10:00	Ebb	7.56	2.37	8.70	8.16
Hoquiam River	9-Apr	Day	10:50	Ebb	7.55	2.94	9.21	8.65
Otterville	14-Apr	Night	22:36	Flood	7.25	0.04	10.05	7.12
Boat Launch	14-Apr	Night	19:10	Flood	7.22	0.06	10.23	8.25
Hoquiam River	14-Apr	Night	18:00	Ebb	7.35	5.25	10.70	7.65
Otterville	15-Apr	Day	7:56	Flood	7.15	0.08	10.60	6.97
Boat Launch	15-Apr	Day	10:05	Flood	7.45	0.17	10.30	7.86
Hoquiam River	15-Apr	Day	11:15	Flood	7.60	3.26	10.66	8.48
Otterville	22-Apr	Night	0:20	Ebb	7.57	0.37	10.70	7.60
Boat Launch	22-Apr	Night	21:45	Ebb	7.66	4.26	11.17	7.13
Hoquiam River	22-Apr	Night	19:45	Ebb	7.86	10.50	11.31	7.05
Otterville	23-Apr	Day	7:00	Ebb	7.71	0.04	10.33	7.16
Boat Launch	23-Apr	Day	9:20	Ebb	7.71	5.32	10.62	7.50
Hoquiam River	23-Apr	Day	10:45	Ebb	7.94	12.72	10.69	8.77
Otterville	4-Jun	Day	14:00	Flood	7.43	5.05	17.94	8.06
Boat Launch	4-Jun	Day	12:00	Flood	7.71	6.02	17.26	8.31
Hoquiam River	4-Jun	Day	10:50	Ebb	7.39	11.60	16.79	8.29
Otterville	5-Jun	Night	1:30	Flood	7.66	3.56	17.17	8.78
Boat Launch	5-Jun	Night	23:10	Flood	7.71	8.83	17.00	8.58
Hoquiam River	5-Jun	Night	21:50	Ebb	8.14	14.00	17.11	8.27
Otterville	12-Jun	Day	14:05	Ebb	8.15	3.21	17.21	8.17
Boat Launch	12-Jun	Day	11:10	Flood	7.21	4.66	17.50	7.88

Table 16. Site name, date, survey strata, time, tide, pH, salinity, temperature and dissolved oxygen concentration measured during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, 2002-2004.

Name	Date	Strata	Time	Tide	pH	Salinity (ppt)	Temp (C)	DO (mg/L)
Hoquiam River	12-Jun	Day	10:45	Flood	7.29	3.29	17.00	7.76
Otterville	13-Jun	Night	21:50	Flood	7.33	13.21	16.59	7.55
Boat Launch	13-Jun	Night	19:30	Flood	7.51	8.89	17.01	8.09
Hoquiam River	13-Jun	Night	18:10	Flood	7.63	5.61	17.00	7.75
Otterville	19-Jun	Day	13:45	Flood	7.73	1.00	18.06	7.82
Boat Launch	19-Jun	Day	11:45	Ebb	7.59	4.73	17.78	7.86
Hoquiam River	19-Jun	Day	10:25	Ebb	7.72	12.77	17.43	8.36
Otterville	20-Jun	Night	20:45	Ebb	7.83	8.77	17.56	9.60
Boat Launch	20-Jun	Night	19:00	Ebb	7.95	9.84	17.63	8.13
Hoquiam River	20-Jun	Night	17:50	Flood	7.95	22.15	16.69	7.49
Otterville	19-Feb-	Day	9:30	flood	8.0	20.10	8.31	7.89
Hoquiam River	19-Feb	Night	1730	ebb	7.5	12.10	8.21	8.01
Otterville	26-Feb-	Day	12:20	flood	8.5	11.50	9.21	779
Hoquiam River	27-Feb-	Night	20:30	ebb	8.0	13.10	9.45	7.21
Otterville	4-Mar	Day	12:50	ebb	8.8	11.19	9.56	7.47
Boat Launch	4-Mar	Day	11:40	ebb	8.5	10.93	10.20	7.74
Hoquiam River	4-Mar	Day	10:30	flood	8.8	20.10	9.75	7.87
Otterville	5-Mar	Night	21:15	flood	7.7	0.82	7.99	7.77
Boat Launch	5-Mar	Night	20:00	flood	7.9	2.95	8.01	7.48
Hoquiam River	5-Mar	Night	19:00	flood	8.3	11.10	9.32	7.56
Otterville	11-Mar	Day	13:00	flood	10.1	0.13	10.12	7.66
Boat Launch	11-Mar	Day	11:00	flood	9.8	2.32	10.52	7.48
Hoquiam River	11-Mar	Day	9:55	ebb	9.5	9.78	10.43	7.57
Otterville	12-Mar	Night	22:00	ebb	9.4	0.20	10.55	7.63
Boat Launch	12-Mar	Night	20:10	ebb	9.4	5.02	10.74	7.28
Hoquiam River	12-Mar	Night	18:45	ebb	10.8	17.40	10.15	7.97
Otterville	19-Mar	Night	21:45	flood	8.9	0.67	10.80	8.04
Boat Launch	19-Mar	Night	20:00	flood	9.3	2.35	12.54	8.06
Hoquiam River	19-Mar	Night	18:30	flood	9.6	14.22	10.65	7.99
Otterville	18-Mar	Day	13:30	ebb	9.4	3.84	11.34	7.93
Boat Launch	18-Mar	Day	9:50	flood	9.5	15.80	10.84	8.09
Hoquiam River	18-Mar	Day	10:15	flood	10.0	30.60	13.28	8.25
Otterville	25-Mar	Day	12:30	flood	10.5	0.84	10.50	8.03
Boat Launch	25-Mar	Day	11:40	flood	9.9	0.93	13.60	7.89
Hoquiam River	25-Mar	Day	10:40	flood	9.9	2.83	13.61	7.86
Otterville	26-Mar	Night	20:45	ebb	9.8	5.45	9.63	7.96
Boat Launch	26-Mar	Night	19:15	ebb	9.9	10.26	13.38	7.9
Hoquiam River	26-Mar	Night	18:15	ebb	9.8	22.00	11.16	8.34

Table 17. Predicted timing of high and low tides during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Survey Date	Survey Strata	High	Low	High	Low
20 June 01	Day	0025	0718	1351	1913
21 June 01	Night	0107	0803		
28 June 01	Day	0734	1348	2028	0244
29 June 01	Night	0849			
6 July 01	Day	0146	0839	1521	2039
7 July 01	Night	0224	0916		
12 July 01	Day	0559	1217	1903	0114
13 July 01	Night	0700			
21 February 02	Day	0648	1413	2044	0153
22 February 02	Night	0758			
28 February 02	Day	0204	0749	1356	2015
1 March 02	Night	0243			
7 March 02	Day	0716	1424	2106	0220
8 March 02	Night	0827			
14 March 02	Day	0136	0727	1330	1943
15 March 02	Night	0205			
18 June 02	Day	0742	1405	2045	0300
19 June 02	Night	0901			
24 June 02	Day	0047	0740	1420	1936
25 June 02	Night	0132	0826		
10 July 02	Day	0113	0810	1454	2008
11 July 02	Night	0157	0853		
24 July 02	Day	0118	0807	1450	2007
25 July 02	Night	0202	0847		
15 August 02	Day	0721	1304	1925	0215
16 August 02	Night	0837			
29 August 02	Day	0600	1129	1751	0044
30 August 02	Night	0659			
12 September 02	Day	0607	1144	1755	0043
13 September 02	Night	0712			
26 September 02	Day	0454	1023	1622	2317
27 September 02	Night	0542			
27-Mar-03	Day	0235	0842	1534	2227
28-Mar-03	Night	0345			
3-Apr-03	Day	0154	0813	1425	2014
4-Apr-03	Night	0219			
8-Apr-03	Night	0505	1233	1916	

Table 17. Predicted timing of high and low tides during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, Washington, 2001-2004.

Survey Date	Survey Strata	High	Low	High	Low
9-Apr-03	Day		0003		
15-Apr-03	Day	1250	0655	1306	1911
16-Apr-03	Night	0128			
22-Apr-03	Night	0543	1246	1933	
23-Apr-03	Day		0053		
4-Jun-03	Day	0343	1057	1749	2257
5-Jun-03	Night	0427			
12-Jun-03	Day		0615	1242	1809
13-Jun-03	Night		0012		
19-Jun-03	Day	0510	1151	1841	
20-Jun-03	Night		0016		
19-Feb-04	Day	0051	0607	1215	1851
20-Feb-04	Night	0133			
26-Feb-04	Day	0447	1125	1733	2305
27-Feb-04	Night	0519			
4-Mar-04	Day		0515	1117	1755
5-Mar-04	Night	0031			
11-Mar-04	Day	0342	1025	1642	2217
12-Mar-04	Night	0419			
18-Mar-04	Day		0502	1114	1742
19-Mar-04	Night	0020			
25-Mar-04	Day	0322	1003	1622	2151
26-Mar-04	Night	0349			

5. DISCUSSION AND CONCLUSIONS

The objective of this study was to determine presence/periodicity of native char use in the lower Chehalis River/Grays Harbor. Previous to this study, periodic accounts of native char residing in the lower Chehalis River (see Appendix C for pre-study literature review prepared for Corps by HDR). To achieve this objective, we conducted two separate, but interrelated tasks. The first component involved a thorough search of the historical research data that has been collected within the Chehalis River basin to obtain records of native char captures. Secondly, based on documented historic captures of native char, we prepared a study plan to examine the presence of native char in the lower Chehalis River/Grays Harbor outside of the time period that was established from the historical captures. The Corps, as a conservation measure, instituted this study for native char residing within the Navigation Channel in order to minimize negative impacts to a threatened species.

5.1 NATIVE CHAR PRESENCE/PERIODICITY IN PROJECT AREA

Fifteen (15) historical native char captures were documented within the lower Chehalis River basin from 1966 through 2000. We captured and additional fifteen (15) native char during the 2001-2004 survey period, fitting seven of those with acoustic transmitters. Our study results are consistent with the historical native char captures that indicate native char are present in the lower Chehalis River beginning in early mid- to late February and continuing through mid-July. The relatively low number of native char (N=30) documented in this study should not be confused as an estimate of abundance as it likely a result of the difficultly encountered in studying this species in large estuarine environments (Pentec 2001). Similar results have been obtained from beach seine surveys conducted in the estuaries of the Puyallup (F. Goetz, USACE, *pers. comm.*), Snohomish (Pentec 2002), and Skagit (E. Connor, Seattle City Light, *pers. comm.*) rivers, as well as the nearshore Puget Sound (Taylor Associates 2002; Goetz et al 2004). For example, beach seine surveys within the Federal Navigation Channel in the lower Snohomish River captured 0.054 native char per haul (1 char 19 seine hauls^{-1}), similar to the 0.021 char per seine haul (1 char 47 seine hauls^{-1}) that was experienced in the lower Chehalis River/Grays Harbor during the 2001-2002 study period.

Including the beach seine surveys conducted in this study during 2001-2004, 30 native char captures have occurred in the Chehalis River from approximately 5,000 beach seine/tow net/purse seine hauls (0.006 char haul^{-1}) (Figure 18). One documented native char capture was the result of fyke net surveys conducted in a slough restoration site near Cosmopolis (Simenstad et al. 2001). Effort data from this and other similar surveys is not included, thus the 5,000 should be considered a minimum estimate of effort. Despite these overwhelming odds, the presence/periodicity of native char should remain constant throughout the survey period. Native char have not been documented in the lower Chehalis River/Grays Harbor from 15 July through mid- to late February. On 27 January 2003 the USFWS revised the in-water work window for lower Chehalis River/Grays Harbor by restricting the Corps to conduct channel maintenance activities from 16 July through 31 August and again from 15 October through 15 February (Figure 19). The periods beginning 16 February through 15 July and 1 September through 14 October represented the windows when "bull trout are most likely to be in those designated areas of the estuary" (USFWS 2003a). In March 2003, the USFWS rescinded the 1 September through 15 October recommended closure and adopted the previous window that allowed the Corps to conduct channel maintenance activities in the lower Chehalis River/Grays Harbor from 16 July through 15 February (USFWS 2003b).

A substantial body of evidence collected through this study indicates that native char are least likely to be present in the lower Chehalis River/Grays Harbor from 16 July through the end of February (Figure 19). Based on preliminary results of a similar, but larger in scope study conducted on the lower Skagit River, native char show similar periodicity patterns as the char residing in the Chehalis River (Goetz et al 2004). Unlike the Skagit River, native char do not appear to spawn in the Chehalis River basin and probably originate from spawning populations of native char in the Olympic Coast rivers located more than 70 miles north of subsequent capture locations in lower Chehalis River/Grays Harbor (Figure 20). Two native char fitted with acoustic transmitters were recaptured in the Hoh River basin, more than 80 miles from Grays Harbor, by steelhead anglers in 2004 and in 2005 (Table 15). Like the native char residing in Puget Sound streams, native char also display an innate sense of site fidelity (Goetz et al 2004). More than 50% of the native char fitted with acoustic transmitters returned to the Chehalis River in subsequent seasons, one char (Char No. 24) returned to the exact location in three subsequent seasons before the battery appeared to fail in 2005.

Native char appeared to display a preference for the mainstem reach of the Chehalis River from the Lumberyard stations downstream to the Bridge stations as over 90% of the telemetry detections (both mobile and fixed stations) were recorded in this reach. Only one char was detected as far upstream as the Cosmopolis stations, while a single char was detected during a mobile survey conducted in the lower reaches of the Hoquiam River. Native char were not detected during mobile surveys conducted upstream or downstream from the project area nor at the Half Moon Bay fixed station.

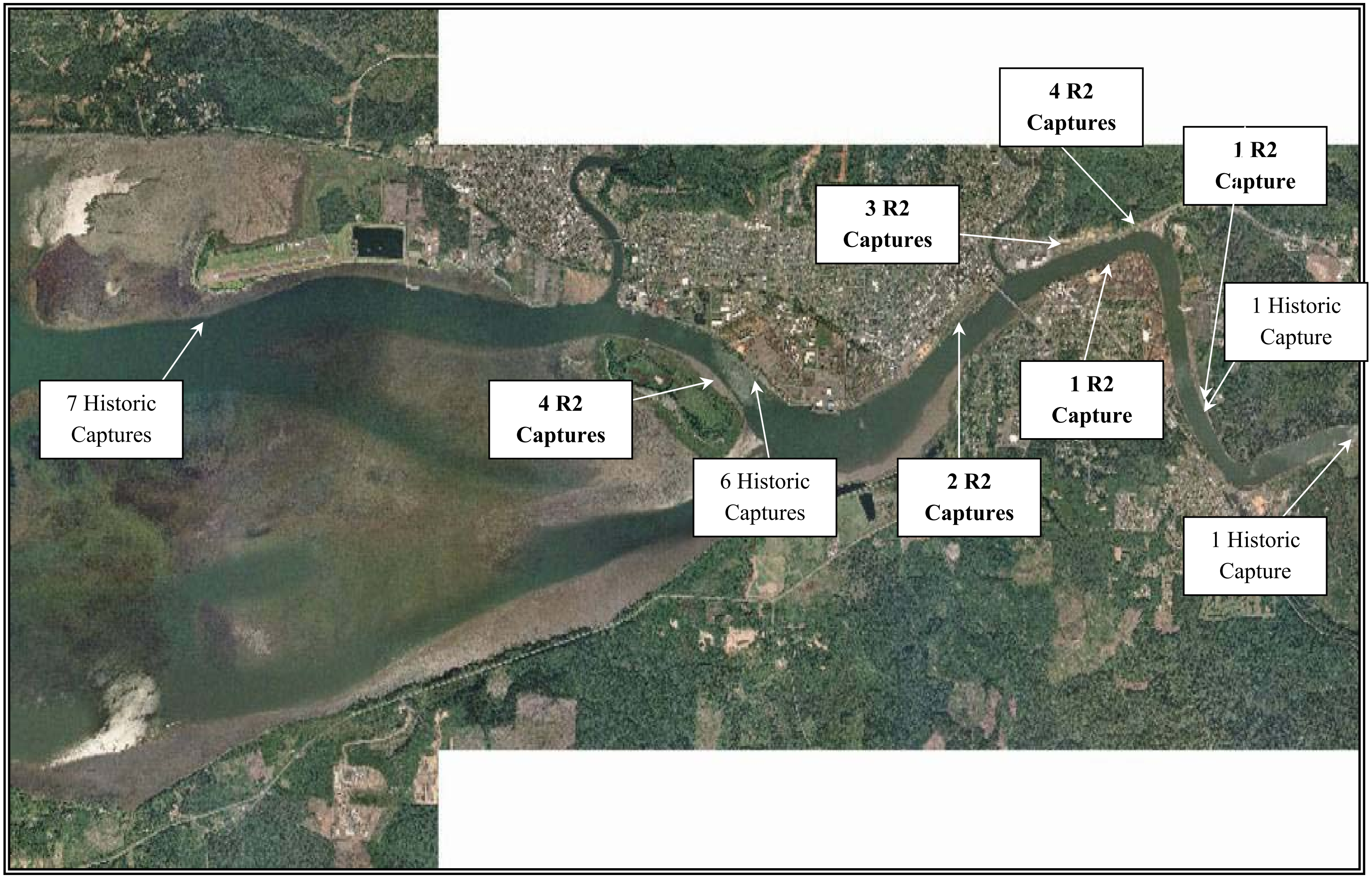

Figure 18. The location of 23 (15 historic and 8 R2) native char captures during beach seine surveys conducted in the Chehalis River basin, Washington, 1966-2004.

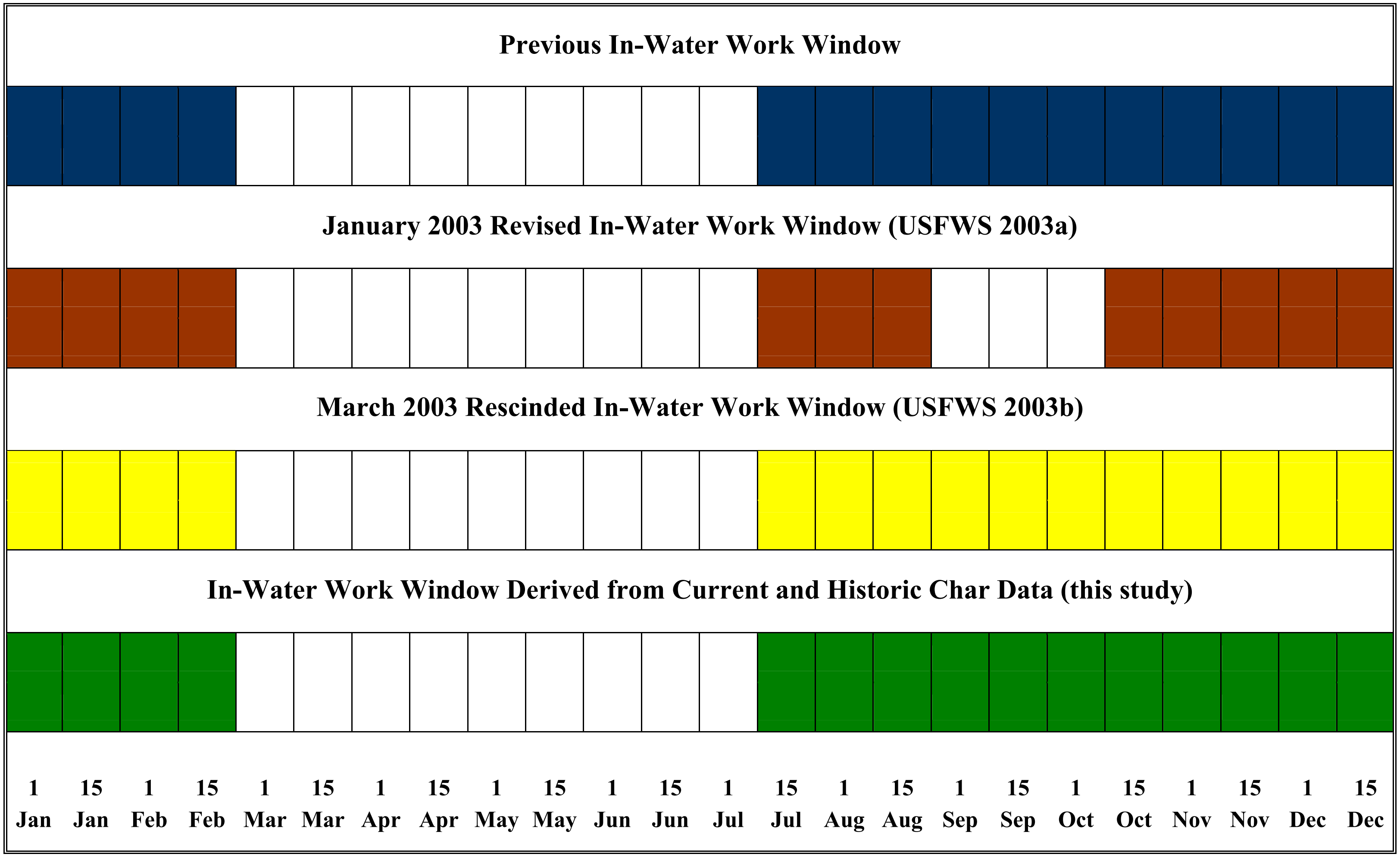

Figure 19. Chronology of native char in-water work windows, lower Chehalis River/Grays Harbor Federal Navigation Channel.

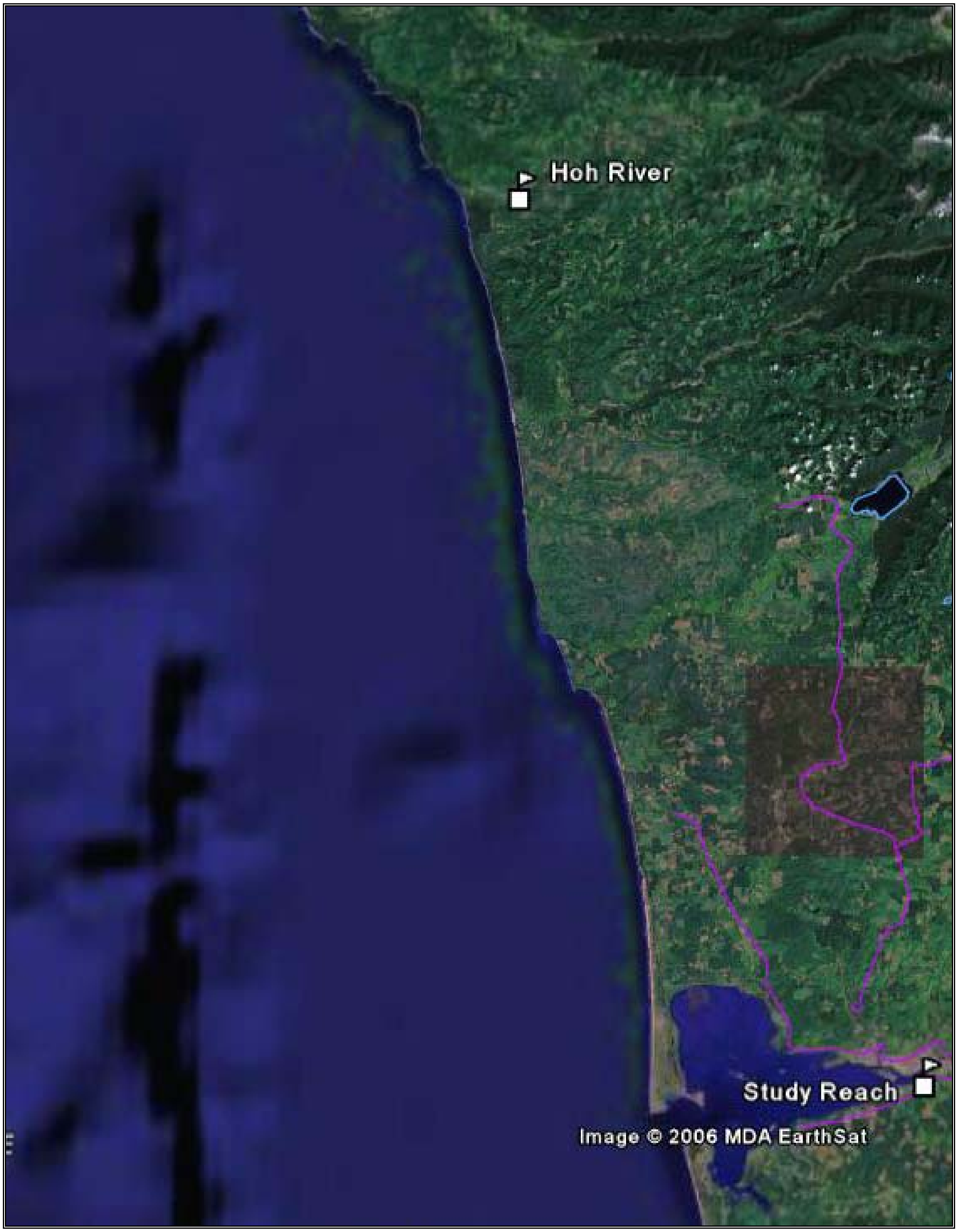

Figure 20. Location of Hoh River basin relative to the lower Chehalis River/Grays Harbor, Washington study reach (adapted from Google Earth).

5.2 NATIVE CHAR AGE/GROWTH

In addition to studying the presence/periodicity, an additional objective of this study was to determine the age and genetic origin of native char in the lower Chehalis River/Grays Harbor. Tissue samples collected from this study will be processed with a larger sample size to determine both the identity of the species (bull trout or Dolly Varden) as well as the origin or core population of the individuals.

Age/growth information collected from the fifteen (15) native char captured in the lower Chehalis River/Grays Harbor indicate that four mature adults (FL=520, 475, 388, and 382 mm) and six sub-adults were present (Table 13). The adult native char appeared to be age-6+, 5+, and age-4+, all maturing at age-4, spawning during the previous three seasons (6+), two (5+), and the previous season (age-4+) (Figures 21-23). The remaining eleven char were sub-adults of ages 3+ (N=6) and 4+ (N=5) with no definitive spawning checks (Figure 24). A spawning check was identified by an uneven scar appearing as cutting through the circuli (Pratt 1991). Age at maturity information from native char residing in the Chehalis River appears to be similar to Skagit River native char. Kraemer (2003) found that nearly all Skagit River native char mature at age-4, with only the rare fish maturing at age-3 or age-5. The age-4 sub-adult (FL=372 mm) had a possible spawning check; however, it was not definitive and was classified as a sub-adult.

Length at age information indicate that the majority native char captured in the lower Chehalis River/Grays Harbor appeared to have smolted at age-2+ as evidenced by the increase in fork length between age 2 and age 3 (Table 13). The overall growth witnessed between age-2 and age-3 (88 mm) was identified as an indication of smoltification. Definitive spawning checks were only identified on two native char scales (Char No. 7 and Char No. 8); the back-calculated length at age of maturity of those fish is 291 and 382 mm FL, respectively (Table 13) (see appendix D for entire scale record). The age/growth information collected from lower Chehalis River/Grays Harbor native char coincides with the information collected from native char in northern Puget Sound. Fluvial native char in the Skagit River reach maturity at lengths of approximately 350 mm, while anadromous char average from 425-450 mm TL at maturity (Kraemer 2003). The majority of the char captured in smolt traps located on the lower Skagit River near Burlington are age-2+ (Goetz et al 2004). Anadromous native char in the Skagit River frequently grow more than 100-, and in some cases 200, mm per season (Kraemer 2003; Goetz et al 2004). Recent information also indicates that native char can switch life history patterns ostensibly to take advantage of a particular forage base (Kraemer 2003).

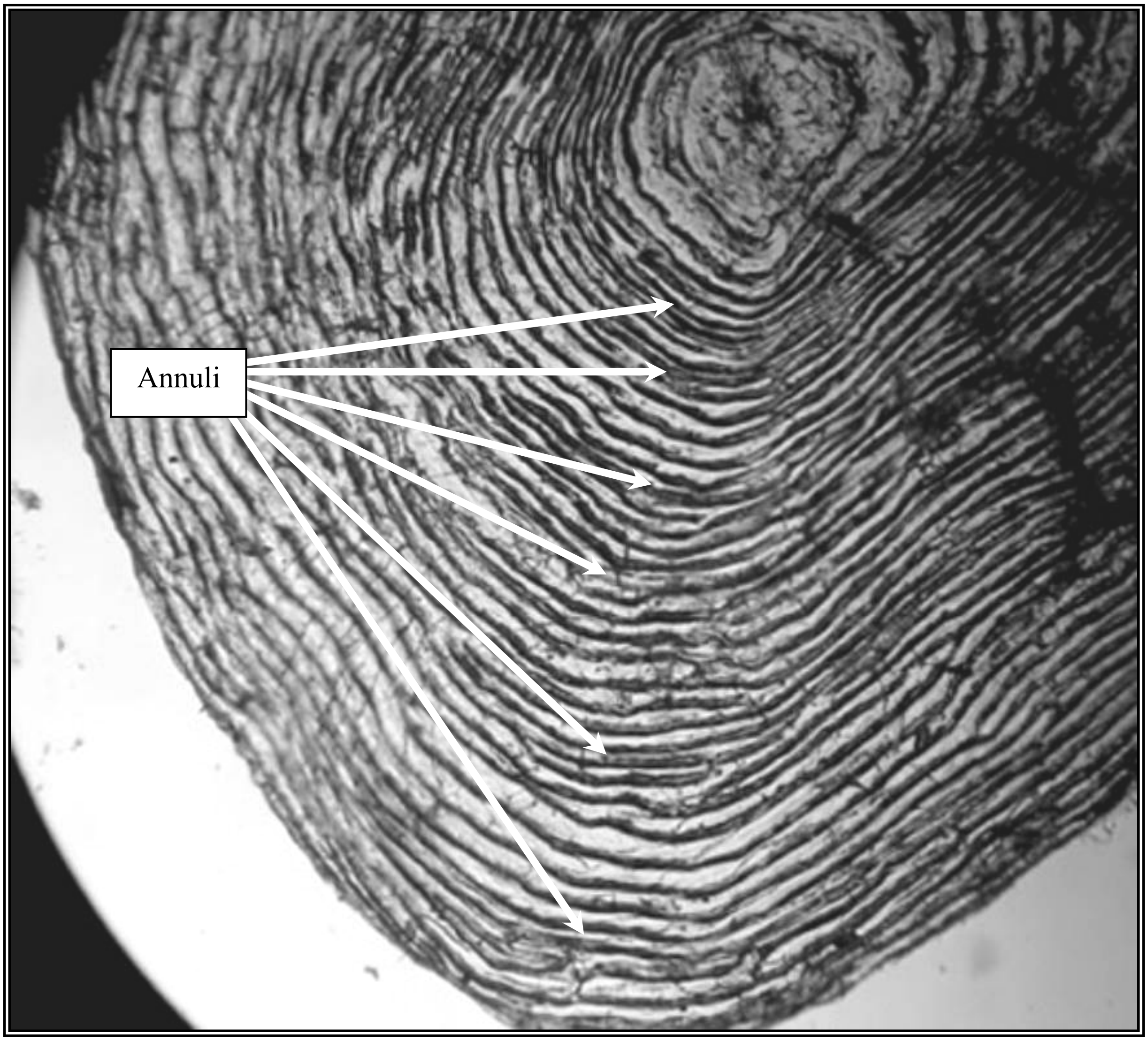

Figure 21. Scale sample from Char No. 23 (FL=520 mm; age-6+) denoting annuli, captured during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, Washington, 2002.

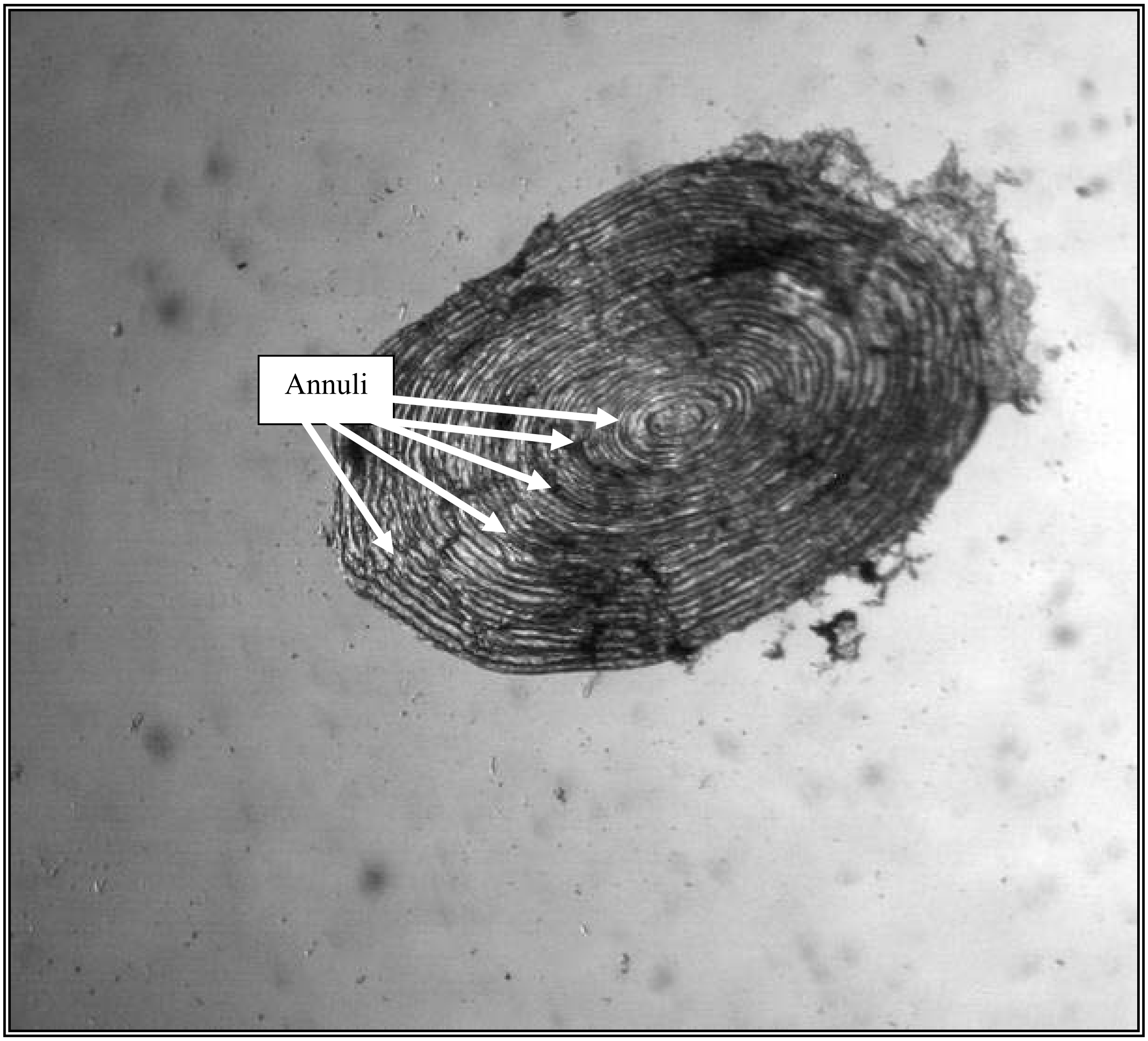

Figure 22. Scale sample from Char No. 29 (FL=382 mm; age-5+) denoting annuli, captured during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, Washington, 2004.

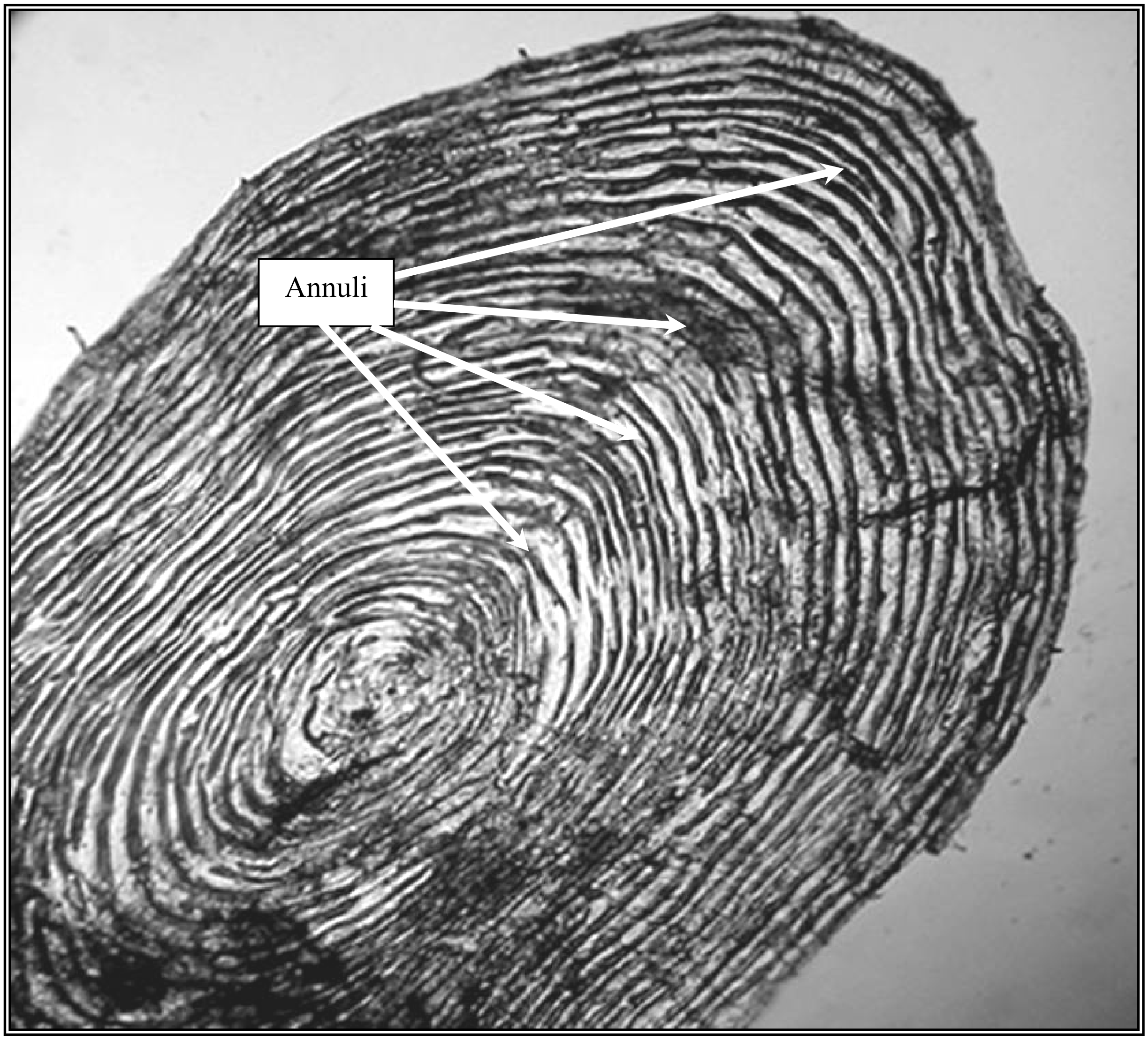

Figure 23. Scale sample from Char No. 22 (FL=388 mm; age-4+) denoting annuli, captured during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, Washington, 2002.

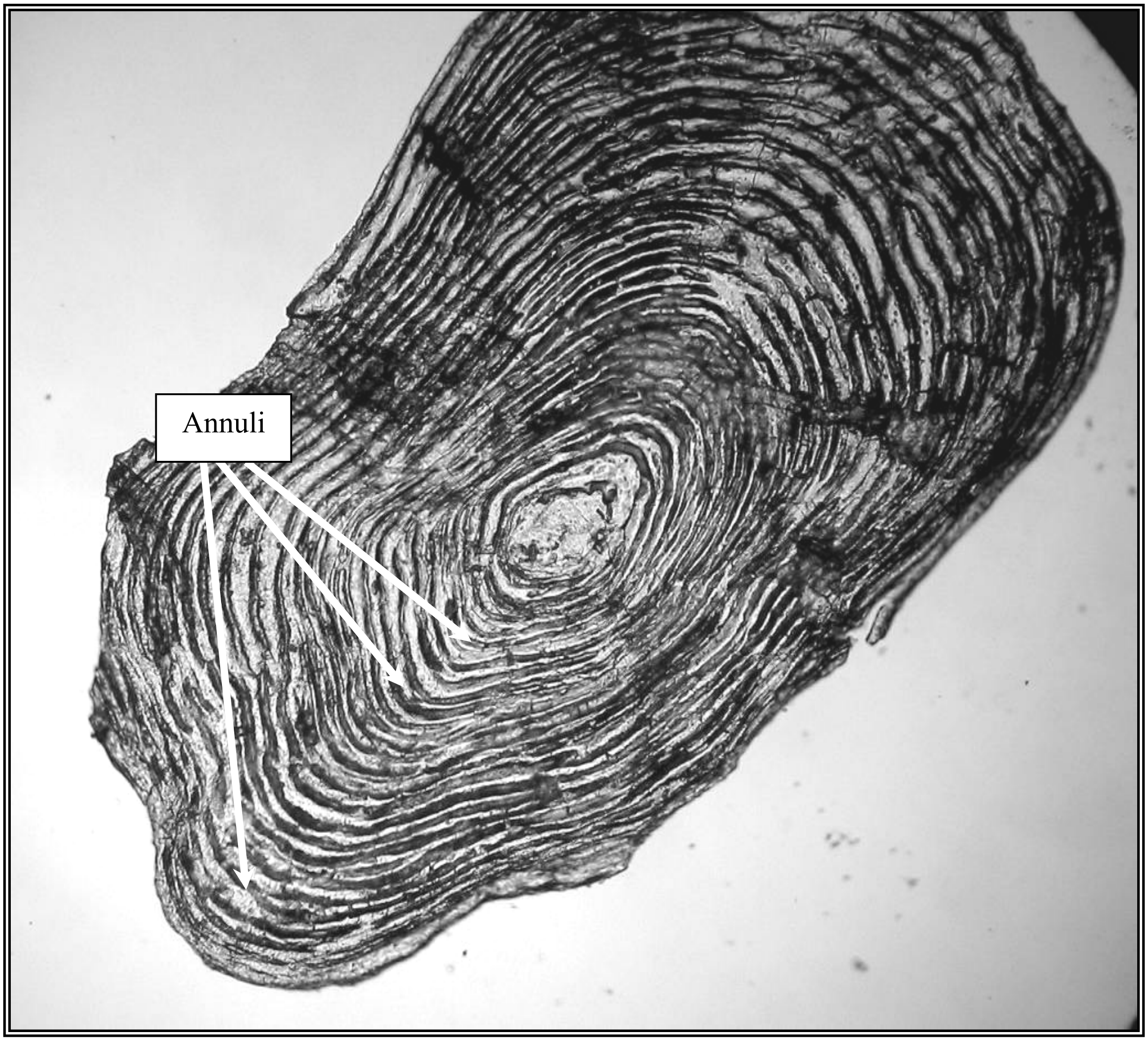

Figure 24. Scale sample from Char No. 17 (FL=326 mm; age-3+) denoting annuli, captured during beach seine surveys conducted in the lower Chehalis River/Grays Harbor, Washington, 2002.

6. SUMMARY

The overriding objective of this study was develop a periodicity of residence time in the Grays Harbor Navigation Channel, specifically those reaches occurring from the mouth of the Hoquiam River proceeding upstream to Cosmopolis. The in-water work window beginning 15 July through 15 February adequately brackets the native char presence in the lower Chehalis River. As additional information is collected from native char populations in the Pacific Northwest, there will no doubt be more unique life history attributes revealed for this adaptive species. As this information is obtained and disseminated, a more thorough life history model of native char in the Pacific Northwest will be developed that will hopefully aid in the recovery of this threatened species.

This study illustrates the importance of taking a conservative approach when it comes to ESA species. In the early stages of this program, a literature review indicated that “establishing a formal monitoring program for this Grays Harbor native char is not recommended” (Appendix C). However, as more information became available, the Corps developed this telemetry study as a conservation measure for native char and along the way provided valuable life history information for the recovery of this species. Bull trout in the Hoh River basin appear to make similar migrations as those in the Puget Sound. Brenkman and Corbett (2005) found these fish moving downstream to the estuary as early as December and upstream to spawning area in July-September. Skagit River anadromous char commonly move downstream to the estuary in January-March period and are typically back in fresh water by the middle of July (Goetz et al. 2004). The preservation of this life history component should be a primary component of all conservation and recovery strategies for the native char species in western Washington.

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